Annexure_TQR_765kV_GIS

Technical Qualifying Requirement for 765 kV GIS Switchyard

The Vendor should have Manufactured, Supplied, Erected/Supervised erection, Commissioned/Supervised Commissioning of one (1) Gas Insulated Switchgear (GIS) Installation having at least One (1) bay of 765 kV or above voltage class with a short circuit rating of not less than 40 kA for 1 second and the above GIS bays should have been supplied from their own Indian manufacturing facility. Documentary evidence meeting the above requirement shall be submitted to the Owner.

NOTE:- For the purpose of qualifying requirement, one no. of bay shall be considered as comprising of at least one circuit breaker, two disconnectors and single phase current transformers.

PREPARED BY
16/10/2023

CHECKED BY
16/10/2023

APPROVED BY
16.10.23.
VIVEK KAPIL

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NOIDA

DOCUMENT NO.	TB-PBTU-POWERGRID-765kV GIS	Rev 01	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	JK	MM	VK
TITLE 765 kV Gas Insulated Switchgear with its accessories		SIGN			
		DATE	13/10/23	13/10/23	13/10/23
		GROUP	TBEM		
		WO No.			

CUSTOMER	M/s NLC India Limited
CONSULTANT	M/s Development Consultants Pvt. Ltd
PROJECT	Pre-bid tie up for GIS Substation Package 3x800 MW coal based Thermal Power Station for NLC India Limited (NLCIL) at Jharsuguda, Odisha

Contents

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

Rev. No.	Date	Altered	Checked	Approved	
01	19/10/23				Revised Inline with Customer Corrigendum
Distribution				To	
				Copies	

CONTENTS

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

1. SCOPE

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

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

Mechanical / Chemical Anchors Bolts are to be provided in place of foundation bolts

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. 765kV
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)

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I. TECHNICAL PARAMETERS:

765kV GIS comprising of three (3) nos. of GT bays, two (2) nos.. (765 / √3) / (400/ √3) / 33 kV of ICT bays, one (1) no. of Bus reactor bay, two (2) nos. of outgoing line bays with switchable line reactor & two (2) nos. of outgoing line bays without switchable line reactor, One spare Bay and Space for one diameter of future GT-4 bay.

Bus bar configuration shall be one and half breaker scheme for 765kV. The short circuit rating of 765kV GIS and its associated equipment shall be designed for 50KA for 1 sec. System shall be solidly grounded.

Rated Normal Current for 765kV Bus bar shall be 4000A
Rated Normal Current for 765kV Feeders shall be 3150A

Gas Insulated Switchgear (GIS) (765kV/400kV/33kV) - Complete GIS with breakers, isolators, fast acting earth switches, bus bars, instrument transformers, bus surge arrestor, etc. inside gas chamber of GIS, On Line Partial discharge monitoring system, numerical relays, meters, transducers, interposing relays, terminal blocks, selector switches, etc. in separate Panels e.g. Local Control Cubicle (LCC), etc. along with, SF6 bus duct, SF6 to Air Bushing & accessories, as required including as detailed in GIS section. Bus bar configuration shall be one and half breaker scheme for 765kV. The short circuit rating of 765kV GIS and its associated equipment shall be designed for 50KA for 1 sec. 765Kv System shall be solidly grounded.

Insulation Co-ordination study including the followings shall be conducted by bidder for most onerous condition and submitted for approval during Basic Engineering stage.

a) Insulation Co-ordination Study report
b) VFTO generated for GIS installation.
c) Calculation for adequacy of UHF sensors to be provided in GIS Installation
d) The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure.
e) Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers.
f) Calculations in support of touch & step voltages in all enclosures and earthing of complete GIS installation.

g) Measures to mitigate transient enclosure voltage by high frequency currents.

GIB Duct: Single phase gas insulated busduct will be used for connection of GT / ICT / Reactor to respective GIS modules. The bus system shall be capable of withstanding the mechanical and thermal stresses due to short circuit current, as well as thermal expansion and contraction due to temperature cycling.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted (subject to owner's approval). In such cases, copies of the English version of the standard adopted shall be submitted along with the bid.

3.17.00 **System Particulars**

Description	765kV /400kV System	33kV System	11kV System	3.3kV System	415V System		240V System	220V DC System
					General	Lighting & Welding		
Nominal Voltage	765kV /400kV	33kV	11kV	3.3kV	415V	415V	240V	220V
Highest System Voltage	800kV /420kV	36kV	12kV	3.6kV	457V	457V	264V	242V
Number of Phases (Conductor)	Three (3)	Three (3)	Three (3)	Three (3)	Three (3)	Four (4)	Two (2)	Two (2)
Frequency	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	NA
Voltage Variation	±5%	±10%	±10%	±10%	±10%	±10%	±10%	+10% to – 15%
Frequency Variation	±5%	±5%	±5%	±5%	±5%	±5%	±5%	NA

Combined Vol. & Freq. Variation	10%	10%	10%	10%	10%	10%	10%	NA
Neutral Earthing	Solidly Grounded	Solidly Ground -ed	Medium Resistance Grounded	Medium Resistance Grounded	Solidly Grounded	Solidly Grounded	Solidly Grounded	Un-grounded
Design Fault Level to be adopted	50kA /63kA for 1 second	31.5kA for 1 second	50kA for 1 second	40kA for 1 second	50kA for 1 second	20kA for 1 second	9kA	25kA$ for 1 second

Note: $$ denotes fault level at DCDB level shall be 25kA while at DLDB level fault level shall be 9kA.

3.18.00 **Insulation Levels**

Nominal System Voltage	Rated 1min Power Freq. Withstand Voltage (kVrms.)	Rated Lightning Impulse Withstand Voltage (kVpeak)
765KV	830(Dry)/870(Wet)	2100
400KV	630 (Dry) / 680 (Wet)	1425
33kV	70	170
11kV	28	75
3.3kV	10	40

SYSTEM DATA:

1.	SYSTEM VOLTAGE	765kV
2.	HIGHEST SYSTEM VOLTAGE	800kV
3.	NO. OF PHASE	3
4.	FREQUENCY	50Hz
5.	ONE MIN. POWER FREQUENCY WITHSTAND VOLTAGE(DRY/WET)	830/870kV (r.m.s.)
6.	LIGHTNING WITHSTAND VOLTAGE	2100kVP
7.	SWITCHING IMPULSE VOLTAGE	1550kVP
8.	SHORT CIRCUIT LEVEL	50kA FOR 1 SEC.
9.	CREEPAGE DISTANCE	31mm/kV
10.	TYPE OF EARTHING	SOLIDLY GROUNDED
11.	LA	624kV
12.	BREAKER RATING	3150A
13.	ISOLATOR RATING	3150A
14.	BUS RATING	4000A

Maximum radio interference voltage for frequency between 0.5 to 2MHz in open & close condition (Micro volt)-as per IEC 62271-1, Cl.7.9.1

In the event of conflict between requirements of any two clauses of this specification/documents or requirements of different codes/standards, specified, the more stringent requirement as per the interpretation of the purchaser shall be the final.

CT & VOLTAGE TRANSFORMER PARAMETERS

Please refer attached Annexure for CT Parameters.

VOLTAGE TRANSFORMER: Shall have 3 no's secondary winding each shall have accuracy class 0.5&3P, 0.5&3P, 0.2 with rated burden 50VA with voltage factor 1.2 continuous and 1.5 for 30 Sec. The parameters are subject to change during detailed engineering.

For ABT metering required CT & PT cores for (Main & Check) and separate core for third ABT meter shall be provided inside the GIS for GT, ST, ICT, IBT & Reactor Feeders.

The CT / VT Parameters indicated are provisional and subject to change during detailed engineering.

However, in a case of **addition / deletion in number of core / winding of CT / VT** the relevant BOQ item shall be operated for cost settlement.
bps item*: "addition / deletion of 1 phase 1 core GIS current transformer (if required in detailed engineering)"*
bps item: *"addition / deletion of 1 phase 1 core / winding GIS voltage transformer (if required in detailed engineering*

II. BILL OF QUANTITIES:

Please refer Annexure_BOQ_765kV_GIS for details

During tender stage No of bays of GIS may vary. No of bays of GIS shall be finalized after receipt of Notification of award (NOA) from NLC.
Overall contract value may vary +/- 30%.

III. SPECIFIC TECHNICAL REQUIREMENTS:

1. Attached Layout is provisional and subject to change in detailed engineering stage.
2. Please refer Section-2 clause 4.48.00 GIS HALL LAYOUT CRITERIA, **Clear space of**

5 meters shall be provided on three sides of the GIS equipment for easy movement along with equipment / trolley. Building width shall be decided considering the requirement of turning radius to rotate the largest removable component for assembly/disassembly.

3. Roads and Rail roads for Switchyard shall be provided as indicated in the Plot Plan Drawing 18A03-DWG-M-002A.
4. Gas barriers shall be provided in line with Gas Single Line Diagram (DWG.No. 18A03-DWG-E-0002) as a minimum requirement, and to meet Service continuity requirements.
5. Rated Normal Current Bus bar: 765kV : **4000A**
6. Detailed 3D Model drawing in AutoCAD is to be submitted by GIS manufacturer during contract stage
7. Bidder to ensure GIS met service continuity requirement.
8. All technical details of GIS are as per **SECTION-2.**
9. For GIS equipment, **high frequency earth grid shall be provided by bidder**. **Dedicated Copper Earth mat** of adequate size embedded in the concrete i.e. below FFL of GIS building shall be provided. Same shall be connected to below ground earth mat of GIS building. In the proposed HF earthing grid, welding of copper bars shall be made to ensure the proper continuity. The connection between below ground mat & HF earthing grid shall be made in such a way that the connection of earth grid conductors shall be intact for 30 years.
10. Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the 765kV GIS substation are deemed to be included in the scope of the specification unless specifically excluded.
11. Actions required in case of defects observed during warrantee period
    a. SF6 gas leakage: Repair/ replacement
    b. High Dew point of SF6 gas (> -36 deg C at atm press): Re-Processing of gas and replacement of Gas in case of no improvement
    c. Replaced/Repaired/Refurbished Equipment (or part of equipment) shall have 2 years warranty without prejudice to contractual warranty period.
12. Any clarification(s) for **GIS** published by M/s NLC with reference to subject project will also valid for this specification.
13. Insulation Co-ordination study shall be conducted by bidder for most onerous condition and submitted to BHEL for approval during Basic Engineering stage.

14. LCC for Bus Measurement Bay if any separately required, the same shall be deemed inclusive in the scope of supply with respective Bus Measurement Bay BOQ line item.
15. TRAINING AT GIS FACTORY / SITE: Training are to be provided to Customer & BHEL executives at GIS Manufacturer Factory / Project Site for 765kV GIS System. Trainee's Hotel Charges, lodging boarding & travel charges are NOT in bidder's scope.

IV. OTHER TECHNICAL REQUIREMENTS:

1. Bidder to note that number of 765 kV bays / breakers shall be as per SLD. Plot plan Layout is indicative and shall be finalized during detailed engineering stage.
2. 765kV connection arrangement of switchable line reactor bay shall be such that it can be used as line reactor as well bus reactor with suitable NGR Bypass arrangement.
3. 765KV SF6 GIS AUXILIARY BUSBAR MODULE FOR SPARE LINE REACTOR are to be provided as per CEA guidelines. Including and not limited to the follows: Set of isolated phase, 765kV SF6 gas-insulated metal enclosed Auxiliary busbar module for connection with spare Reactor comprising of following:
    a. One (1) number 1-Phase, Auxiliary bus bar enclosure running across the length of the switch gear to inter-connect the spare unit of Reactor with all Reactor bay modules under present scope through GIS ducts.
    b. One (1) number 1-phase, single pole operated safety grounding switch, complete with manual and motor driven operating mechanisms.
    c. One (1) number 1-phase, 3150A, SF6 ducts inside the GIS hall (up to the outer edge of the wall of GIS Hall)
    d. Gas monitoring devices, barriers, pressure switches, UHF PD sensors, support structure etc. as required.
    e. End Piece (Interface) module with the test link for future extension. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.
4. Each Line Reactor Bay shall have additional modules for interfacing with auxiliary bus module for Spare Line Reactor. Cost of the same shall be deemed inclusive of respective Line Reactor GIS Bay cost. This includes and not limited to three Nos. 1-phase, individual pole operated isolator switches, complete with manual and motor

driven operating mechanisms for switching of spare Reactor through 765kV auxiliary bus. The isolator must meet the operational requirement in terms of Phase-Phase insulation withstand capability. Complete as per system requirement.

5. Adapter box for extension of GIS: This End Piece / Interface module with the test link for future extension of Bus bar module / GIB. The end piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.
6. PROVISION FOR FUTURE SWITCHABLE LINE REACTOR BAY INCLUDING INTERFACING MODULE: Please refer SLD. (associated with lines Sundargarh ss LILO-01 & Sundargarh ss LILO-02) Space and connections modules in both the line bays are to be considered for future line reactor bay. The space are to be considered in layout and necessary interfacing module are to be provided so as to smooth interfacing of line reactor bay in future course as if required. Layout are to be planned accordingly.
7. Line reactors for 765kV Line feeders shall be 765kV, 3x80 MVAR, ONAN type, for each of Two (2) line feeders, with one Spare 80MVAR Line reactor. 1x240MVAr (3x80MVAr single phase units) switchable line reactor along with 400ohm NGR (with NGR bypass arrangement) shall be provided for each line as indicated in the SLD - 18A03-DWG-E-0002-R1. There shall be total 7x80MVAr single phase units against 2x240MVAr line reactors and the 7th 1-phase unit shall be spare as hot stand by. The Spare 1-phase shunt reactor unit shall be placed and connected in such a way that the spare unit can be utilized without its physical movement, Further the connection arrangement of switchable line reactors shall be such that it can be used as line reactor as well as bus reactor with suitable NGR bypass arrangement.
8. 1x240MVAr (3x80MVAr single phase units) switchable line reactor along with 400ohm NGR (with NGR bypass arrangement) shall be provided for each line as indicated in the SLD -18A03-DWG-E-0002-R1. There shall be total 7x80MVAr single phase units against 2x240MVAr line reactors and the 7th 1-phase unit shall be spare as hot stand by. The Spare 1-phase shunt reactor unit shall be placed and connected in such a way that the spare unit can be utilized without its physical movement, Further the connection arrangement of switchable line reactors shall be such that it can be used as line reactor as well as bus reactor with suitable NGR bypass arrangement.
9. SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION - Complete scope of supply in all respect in compliance to technical specification and

requirements.

10. STRUCTURE MATERIAL INCLUDING FOUNDATION BOLTS, EMBEDDED ITEMS, RAILS AND/ OR OTHER MATERIALS ETC - Complete in all respect in compliance to technical specification and requirements. In the event of changes in present scope, payment shall be made on pro-rata basis of number of circuit breaker bays only.

11. Bidder would like to be clarified that the circuit breakers shall either be horizontal mounted or Vertical mounted based on OEM type tested design.
12. GIS Building shall be One (1) storied RCC framed structure with RCC ground Floor and RCC roof on metal deck. Roof beams shall be of structural steel. Side claddings shall be of Fly ash brick wall. Provision shall be kept for crane for handling of equipment.
13. AC / DC Supply Permissible Variations: The auxiliary power supply system & equipment has been designed for a voltage & frequency variation as given below under worst operating conditions:
    a. AC System: Voltage variation ±10%, Frequency variation +5% to -5%, Combined voltage & frequency variation 10% (absolute sum)
    b. DC System: Voltage variation -15% to +10%
14. The design of all equipment shall also conform to the best and standard engineering practice over and above the specification requirements, applicable codes/standards and Regulations. The design shall ensure reliability to provide uninterrupted service, with low maintenance. In addition, the plant electrics shall be designed to comply with the requirements stipulated in the following regulations and the latest amendments:
    a. Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006;
    b. Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC); Applicable State Grid Code issued by appropriate Regulatory Commission;
    c. Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations, 2010;
    d. Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations, 2011;
    e. Central Electricity Authority (Grid Standards) Regulations, 2010.
15. All electrical equipment and materials shall conform to latest applicable standard

publications of International Electro technical Commission (IEC) or equivalent standards published by the Bureau of Indian Standards (BIS) and other standards mentioned in the various volumes of sections of this specification. In case of a conflict between IEC and other standards, the stringent requirement shall govern.

16. GIS Painting as per OEM design is acceptable. Suggested Colour Coding of Equipment: GIS Colour RAL Code7030.
17. Fast Acting Earthing Switches: 1) Fast acting earthing switches shall be located at the bus bar and at all external HV connections of feeders like HV cables or overhead lines or transformer connections. The Fast Acting Earthing switches shall have inductive and capacitive current switching capability as per IEC-62271-102.
18. The Bidder shall supply all erection materials, hardware and consumables required for the completion of the installation.
19. Maximum weight of gas in a gas tight section of GIB shall not exceed 400 Kg.
20. 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.
21. The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters
22. 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.
23. 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:

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

V. TYPE TEST, INSPECTION & CERTIFICATE:

Please refer Section-2 Clause 6.02.01 **Type Tests.** All equipment being supplied shall proven design & conform to type tests as per relevant standards & technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

The reports for all type tests as per technical specification shall be furnished by the bidder along with equipment / material drawings. However, type test reports of similar equipment / material already accepted in NLC (in the projects similar to present project) shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by NLC or representative authorized by NLC or Utility or representative of accredited test lab.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted not older then last **15 (Years) years from dated 12 July 2022**. In case the test reports are of the test conducted earlier than 15 (Fifteen) years, the bidder shall repeat these test(s) at no extra cost to BHEL / NLC.

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/NLC.

Validity period of type tests conducted on the equipment i.e. the period for which Type Test Reports (TTRs) shall remain valid and acceptable to user/ utility provided no major change has been introduced in the basic design/ technology/material/ mechanical construction/ functionalities of the equipment/ performance characteristic/ manufacturing process of the equipment

Note –

(1.) Bidder to please note, type test report shall be reviewed for comment / approval in detailed engineering stage only.

(2.) The Bidder shall intimate BHEL with the detailed program about the type tests at least two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

(3.) The type tests of the equipment shall be repeated during its validity period, if there is change in technology or basic design or generic materials employed or manufacturing process or combination of any of above. However, minor changes, which have no effect on functionality & reliability of the equipment, may not require repetition of type tests. Minor changes do not include change in electrical stress, thermal stress, mechanical stress, change in construction, change in dielectric material, impregnating oil, thickness of electrode & internal fuse design in a capacitor, enclosure materials (magnetic, non-magnetic like stainless steel, Aluminum) etc.

(BHEL Internal Ref: Vol-II-F1 / Section-1, General Electrical Spec./Clause-14.01.00/ Type test)

VI. SITE TESTING & COMMISSIONING:

Bidder to ensure check and test during installation, testing and commissioning as per relevant national & international standards. Following checks are also to be include for schedule of pre-commissioning tests for GIS & busducts

a. Speed and timing tests for circuit breakers

b. Timing tests for disconnectors and earthing switches

c. Humidity/dew point measurement tests of SF6 gas

d. Voltage drop tests

e. Functional interlocking tests

f. Power frequency voltage test for switchgear and auxiliary circuits at 80% of rated voltage

g. Gas leakage test on each bay with high sensitive gas leakage detector on all seals.

h. Partial discharge measurement

VII. TECHNICAL REQUIREMENTS FOR CSD:

1. CSD shall be deployed for optimization of switching behavior of bidder supplied GIS Breaker.
2. The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations.
3. All 765kV kV Circuit Breaker control schematics shall be finalized in such a way, that it may operate with or without CSD by using a suitable selector switch irrespective of whether circuit breakers to be supplied are envisaged along with CSD or not as per bid price schedules.
4. Complete interfacing with GIS and CSD shall be in bidder's scope. Any additional item like transducer, contact multiplication relay, switches, special/screened cables, modification hardwired, modification in schematics (if any) required for interfacing and for complying to the technical specification requirement shall be in bidder's scope and shall be included in quoted price. No price implication for the same shall be entertained during detailed engineering.
5. All wiring necessary for interface of GIS/ CRP with bidder supplied CSD is also deemed to be included in the scope of bidder. Cables, lugs, ties etc required for connection of CSD in existing relay panel is deemed to be included in bidder's scope.

6. Supervision of Erection only and testing & Commissioning of CSD shall be in bidder's scope.
7. The CSD 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. Cost of the same shall be deemed included in offer.
8. Special cables (i.e., screened/ FO cable) other than 1100V LT Power & Control Cables required for CB / CSD / Relay Panel interfacing shall be in bidder's scope. Mode of measurement for special cable shall be cable-trench running length from GIS to CSD/ Relay panel. Total requirement of special cable qty. is to be estimated & supplied by bidder based on no. of runs etc.

VIII. GIS DESIGN FEATURES:

1. The switchgear shall be of compact and modular design, fully metal-clad and of the sulphur-hexafluoride (SF6) insulated type. It shall be constructed for the indicated busbar system and shall include all necessary switches and current and voltage transformers. The switchgear shall be supplied complete with all auxiliary equipment necessary for operation, routine maintenance, repairs or extensions.

2. The switchgear shall be designed for continuous operation under all system operating conditions including sudden change of load and voltage and short circuits within its ratings. The equipment shall be designed to withstand normal operating voltage even if the inside gas pressure decreases to atmospheric pressure as long as no switching operations are performed.

3. The switchgear shall be constructed of suitable material and thickness to withstand the mechanical and thermal stresses due to short circuits and internal arc faults. For the rated duration of short circuit reference shall be made to the design fundamentals and latest IEC recommendations.

4. The enclosure and seals shall be designed to withstand the gas pressure encountered under normal and short circuit conditions. The thickness of the enclosures shall be in compliance with IEC – 60517.

5. The switchgear line-up, when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault condition. Even

repeated operations up to the permissible servicing intervals, under full rated fault conditions, shall not lead to diminished performance or significantly shortened useful life of the switchgear. Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. Routine replacement of insulating gas shall not be required in intervals of less than ten years.

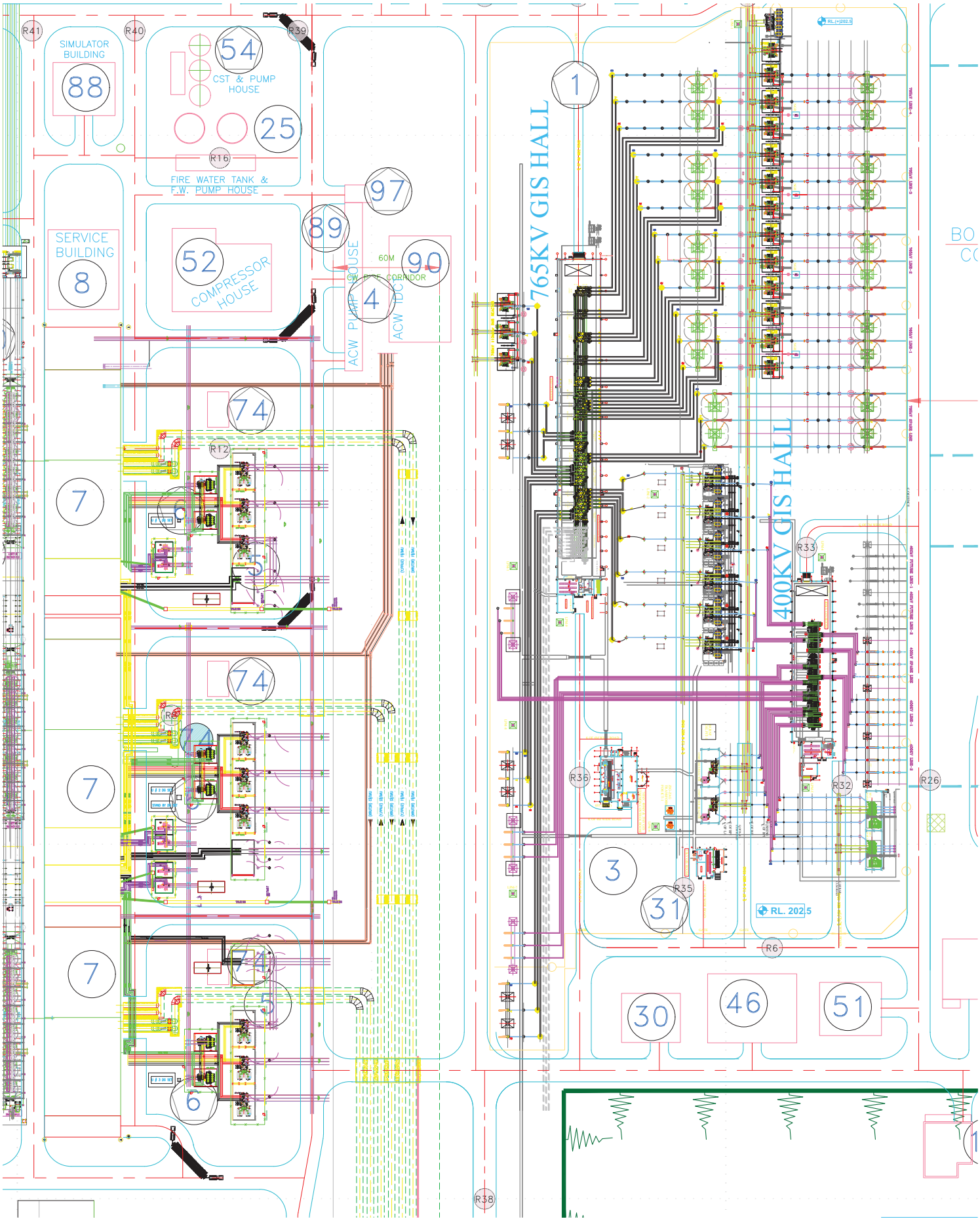
CURRENT TRANSFORMER DETAILS

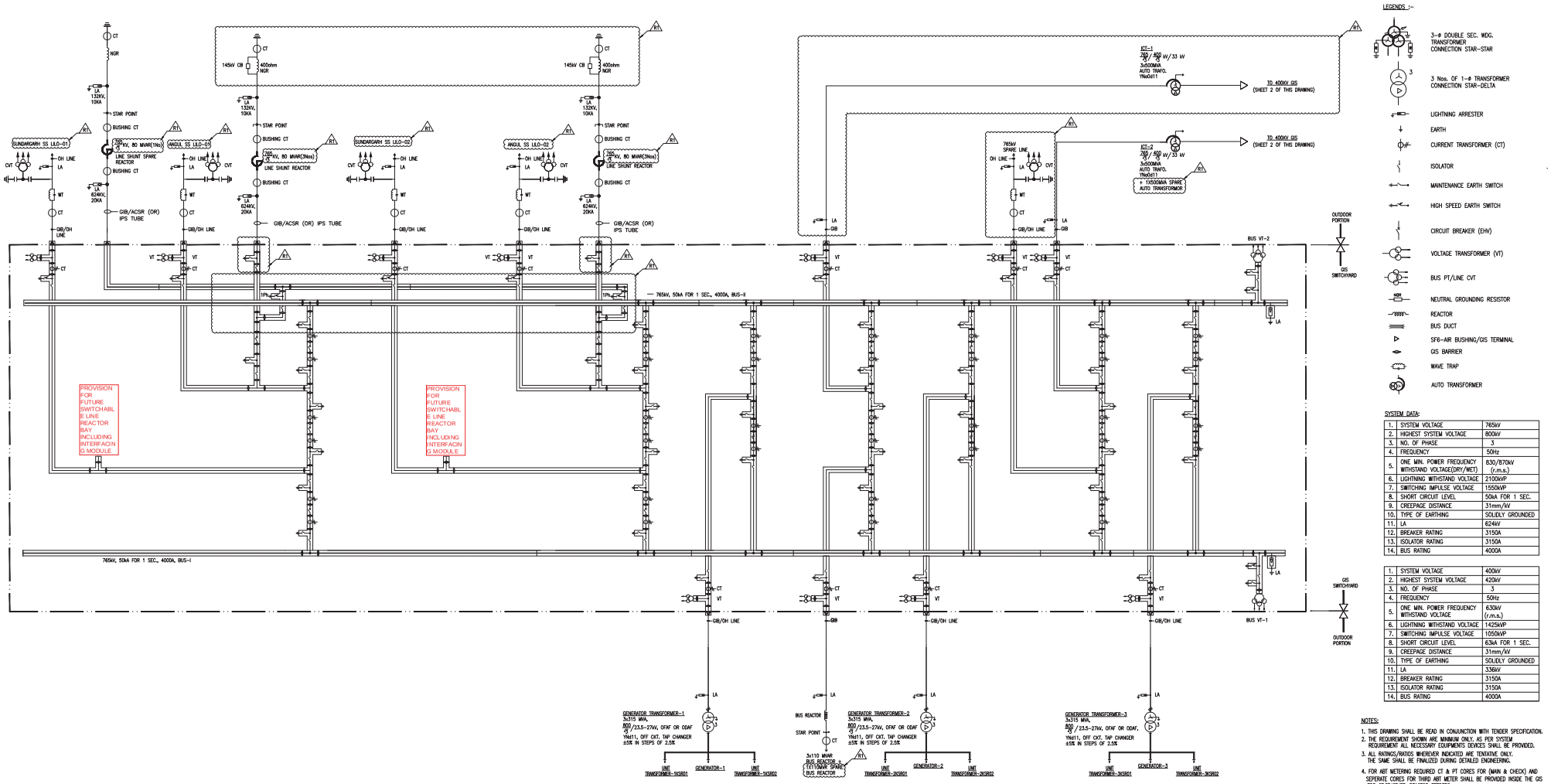
BAY NAME	CT LOCATION	CT CORE No.	CURRRENT RATIO		ACCURACY CLASS	MIN RATED BURDEN (VA)	INSTRUMENT SECURITY FACTOR (ISF)	Min. KNEE POINT VOLTAGE-Vk (V)	Max. CT SECONDARY WINDING RESISTANCE (Ω) (CORRECTED TO 75° C)	MAGNETIZATION CURRENT Im at Vk (mA)	RATED CONTINUOUS THERMAL CURRENT/RATED EXTENDED PRIMARY CURRENT	RATED SHORT TIME CURRENT (kA/sec)
			PRIMARY (A)	SECONDARY (A)								
MAIN BAY	BUS SIDE	C3	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120	% OF RATED PRIMARY CURRENT a) For 500/1A-200% b) For 2000/1A-180% c) For 3000/1A-120%	63 / 1
		C2	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
		C1	3000-2000-1000-500	1	0.2S	20	≤5	-	-	-		
	LINE/GT SIDE	C4	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
		C5	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
TIE BAY CT DETAIL	BUS -1 SIDE	C3	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
		C2	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
		C1	3000-2000-1000-500	1	0.2S	20	≤5	-	-	-		
	BUS-2 SIDE	C3	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
		C2	3000-2000-1000-500	1	PX	-	-	3000-2000-1000-500	15-10-7.5-2.5	20-30-60-120		
		C1	3000-2000-1000-500	1	0.2S	20	≤5	-	-	-		
LINE SIDE CT DETAIL	LINE / ICT/ ST/GT TRANSFORMER	C1	3000-2000-1000-500	1	0.2S	20VA	≤5	-	15-10-7.5-2.5	20-30-60-120		
		C2	3000-2000-1000-500	1	PX	20VA	≤5	-	15-10-7.5-2.5	20-30-60-120		

NOTE:

1. ABOVE CT PARAMETERS ARE INDICATIVE AND SUBJECT TO CHANGE AS PER SYSTEM REQUIREMENT DURING DETAILED ENGG STAGE.
2. ANY ADDITION/DELETION IN NUMBER OF CT CORE SHALL BE SETTELD DURING DETAILED ENGG STAGE AS PER RELEVANT ITEM OF BOQ.

Plot Plan Drawing 18A03-DWG-M-002A.





LEGENDS :-

- 3-ϕ DOUBLE SEC. WDG. TRANSFORMER CONNECTION STAR-STAR
- 3 Nos. OF 1-ϕ TRANSFORMER CONNECTION STAR-DELTA
- LIGHTNING ARRESTER
- EARTH
- CURRENT TRANSFORMER (CT)
- ISOLATOR
- MAINTENANCE EARTH SWITCH
- HIGH SPEED EARTH SWITCH
- CIRCUIT BREAKER (EHV)
- VOLTAGE TRANSFORMER (VT)
- BUS PT/LINE CVT
- NGR — NEUTRAL GROUNDING RESISTOR
- REACTOR
- BUS DUCT
- SF6-AIR BUSHING/GIS TERMINAL
- GIS BARRIER
- WAVE TRAP
- AUTO TRANSFORMER

SYSTEM DATA:

1.	SYSTEM VOLTAGE	765kV
2.	HIGHEST SYSTEM VOLTAGE	800kV
3.	NO. OF PHASE	3
4.	FREQUENCY	50Hz
5.	ONE MIN. POWER FREQUENCY WITHSTAND VOLTAGE(DRY/WET)	830/870kV (r.m.s.)
6.	LIGHTNING WITHSTAND VOLTAGE	2100kVP
7.	SWITCHING IMPULSE VOLTAGE	1550kVP
8.	SHORT CIRCUIT LEVEL	50kA FOR 1 SEC.
9.	CREEPAGE DISTANCE	31mm/kV
10.	TYPE OF EARTHING	SOLIDLY GROUNDED
11.	LA	624kV
12.	BREAKER RATING	3150A
13.	ISOLATOR RATING	3150A
14.	BUS RATING	4000A

1.	SYSTEM VOLTAGE	400kV
2.	HIGHEST SYSTEM VOLTAGE	420kV
3.	NO. OF PHASE	3
4.	FREQUENCY	50Hz
5.	ONE MIN. POWER FREQUENCY WITHSTAND VOLTAGE	630kV (r.m.s.)
6.	LIGHTNING WITHSTAND VOLTAGE	1425kVP
7.	SWITCHING IMPULSE VOLTAGE	1050kVP
8.	SHORT CIRCUIT LEVEL	63kA FOR 1 SEC.
9.	CREEPAGE DISTANCE	31mm/kV
10.	TYPE OF EARTHING	SOLIDLY GROUNDED
11.	LA	336kV
12.	BREAKER RATING	3150A
13.	ISOLATOR RATING	3150A
14.	BUS RATING	4000A

NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH TENDER SPECIFICATION.
2. THE REQUIREMENT SHOWN ARE MINIMUM ONLY. AS PER SYSTEM REQUIREMENT ALL NECESSARY EQUIPMENTS DEVICES SHALL BE PROVIDED.
3. ALL RATINGS/RATIOS WHEREVER INDICATED ARE TENTATIVE ONLY. THE SAME SHALL BE FINALIZED DURING DETAILED ENGINEERING.
4. FOR ABT METERING REQUIRED CT & PT CORES FOR (MAIN & CHECK) AND SEPERATE CORES FOR THIRD ABT METER SHALL BE PROVIDED INSIDE THE GIS FOR GT,ST,ICT,BR, REACTOR FEEDERS.
5. ADAPTER BOX EXTENSION SHALL BE PROVIDED IN 765KV&400KV GIS FOR FUTURE EXTENSION.
6. FOR 33kV GIS GAS SLD REFER DWG NO. # 18A03-DWG-E-0003. (R1)
7. 765kV GIS AUXILIARY BUS ARRANGEMENT FOR SPARE LINE REACTOR SHALL BE PROVIDED AS PER CEA GUIDELINE (R1)
8. 765kV CONNECTION ARRANGEMENT OF SWITCHABLE LINE REACTORS SHALL BE SUCH THAT IT CAN BE USED AS LINE REACTOR AS WELL AS BUS REACTOR WITH SUITABLE NGR BYPASS ARRANGEMENT. (R1)

TENDER PURPOSE ONLY

DS			SC						
DS			SC						
APPROV.	MECH.	INST.	ELEC.	STRL.	ARCH.	REVIEWED			

NATURE OF REVISION & DESCRIPTION	CHECKED	DRAWN	REV.	DATE
GENERALLY REVISED	SC	SM	1	04.09.2023
FOR TENDER PURPOSE ONLY	SC	SM	0	13.07.2023

RELEASE STATUS	DATE	SIGNATURE
PRELIMINARY		
FOR TENDER ONLY	13.07.2023	SC
FOR CONSTRUCTION		
ARCHITECTURAL		
CIVIL & STRUCTURAL		
ELECTRICAL		
INSTRUMENTATION		
MECHANICAL		

APPROVED

OWNER: NLC INDIA LIMITED
NEYVELI, TAMILNADU

PROJECT: NLC TALABIRA THERMAL POWER PROJECT (NTTPP) (3x800 MW)

TITLE: KEY SINGLE LINE DIAGRAM FOR STATION CONNECTION

DEVELOPMENT CONSULTANTS PVT LTD.
CONSULTING ENGINEERS
KOLKATA • MUMBAI • CHENNAI • NEW DELHI

PREPARED	NG	JOB NO.	18A03
CHECKED	AD	SCALE	N.T.S
APPROVED	DS	DATE	03.10.2018

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VOLUME: II-F/1

SECTION-XII

ELECTRICAL LABORATORY INSTRUMENTS & WORKSHOP ELECTRICALS

1.00.00 SCOPE OF SUPPLY

1.01.00 The Scope of supply involves the requirement of Electrical Laboratory Instruments for NLC India Limited, Talabira Thermal Power Project (3x800 MW), Phase-I, Jharsuguda, Odisha.

1.02.00 Equipment and materials shall be as per bill of material mentioned in Annexure-A of this Specification.

1.03.00 All relevant drawings, data and instruction manuals.

2.00.00 CODES AND STANDARDS

2.01.00 All equipment and materials shall be designed, manufactured and tested in with the latest applicable Indian Standards (IS) except where modified and/or by this specification.

2.02.00 Equipment and materials conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.00.00 DESIGN / SELECTION CRITERIA

3.01.00 Electrical laboratory equipment shall be used for testing various electrical equipment/devices during commissioning, operation & maintenance of plant.

3.02.00 Equipment shall be suitable for use in dust-laden, hot, humid atmosphere prevailing in Power Plant area.

3.03.00 Specified features, ratings, ranges etc. are to be construed as the minimum requirement and those are meant for general guidance of the Bidder. Considering the wide product diversities in the electrical measuring instrument field, the Purchaser at his sole discretion, may select a model with a product data that may vary from the specification data.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 The equipment range, rating and quantities are detailed in Annexure-A. Equipment shall be furnished in accordance with the same.

4.02.00 Whether specifically mentioned or not, each equipment/instrument shall be offered as complete with its accessories to make it usable without need to procure any additional components or accessories.

5.00.00 DRAWING, DATA & MANUALS

5.01.00 Drawings, Data & Manuals shall be submitted with the bid and in quantities and procedures as specified in General Condition of Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

5.02.00 To be submitted with the Bid for each piece of equipment - for Bid Evaluation purpose:

a) Filled up data sheets

b) Technical leaflets – detailed version

c) Product-wise reference list mentioning year of supply

5.03.00 To be submitted for each piece of equipment after award of contract - for Approval & Distribution purpose:

a) Guaranteed data sheets

b) Wiring and Schematic Diagrams, if applicable.

c) Instruction / Operation Manual

d) Test Report

e) Calibration certificate traceable to National / International standards

f) Warranty certificate etc.

5.04.00 The equipment Manual (operation & maintenance) shall contain the following data:

a) Installation drawing

b) Circuit or schematic diagram

c) Sequence of operation

d) Wiring diagram

e) List of units in the equipment

f) Maintenance instructions, if any.

5.05.00 The following documents shall be furnished in three copies during inspection/dispatch of the equipment:

a) Test certificates

b) Operation, maintenance and service manual

c) Complete spare parts lists with ordering information.

Fully automatic, microprocessor-based, accurate AC voltage bridge.

- Burnishing tool
- Contact pressure gauge
- Factor gauges
- Testing plugs with link plugs
- Screw drivers
- Nose pliers
- Scissors

Purpose - For monitoring the condition of insulation of electrical equipments

23. PORTABLE CIRCUIT BREAKER MOTION ANALYSER:

For analyzing performance of SF6/Vacuum/air circuit breakers up to 400kV Microprocessor-based capable of measuring, recording and printing opening/closing times and velocity, coil currents, dynamic contact resistance of main/aux and arcing contacts, pole discrepancy etc.

The instrument shall have user-friendly menu driven software for easy operation and reduced setup time. It shall have communication ports for downloading of data from memory on to a PC. It should have a built-in DC battery and printer. Other specifications shall be as follows.

Table: 23.1

S. NO.	FUNCTIONS	PARAMETERS/ FEATURES
1.	Input Supply	110-240V, 50Hz with built-in DC battery backup with charger
2.	Accuracy Current injection	Up to 100A DC
3.	Timing range	0-9.99 S. with a resolution of 0.1 mS and accuracy of + 0.01%
4.	Number of Channels	2 analog, 24 digital
5.	Display	16 character alphanumeric LCD

24. ANALOG MULTIMETER : Table: 24.1

ANNEXURE-B

BILL OF QUANTITY OF ELECTRICAL TESTING LABORATORY EQUIPMENT

S.NO.	DESCRIPTION	MAKE	UNIT	QTY
1.a	Digital Megger / Insulation Tester (up to 1000 V)	Megger / Scope / Baur Inst. / Fluke / AVO	Nos.	2
1.b	Digital Megger / Insulation Tester (up to 5 KV)	Megger / Scope / Fluke / PCI Ltd. / Biddle	No.	1
2	AVO meter	Scope / Motwane / Argonic	No.	1
3	Digital Tong Tester / AC Clamp meter	Motwane / Rishab / Fluke / Megger / AVO	Nos.	4
4	High Voltage Test Set	Motwane / Transformer & Electrics, Delhi / Seba / Megger / Biddle	Nos.	2
5	Digital Tachometer (0-10000 rpm)	SPM Instrument / Agilent / Fluke / Amprobe / Megger	Nos.	3
6	Noise Meter (0-130 db)	SPM Instrument / Agilent / Fluke / Amprobe / Megger	Nos.	2
7	Vibration Meter (0.1 - 50 mm/sec)	Motwane / Scope	Nos.	2
8	Power analyser	Megger / Baur Inst.	No.	1
9	Surge tester 0-10 KV	Megger / Scope / Baur Inst	Sets	2
10	Phase Sequence Indicator	Megger / Scope / Baur Inst	No.	1
11	Mercury Thermometer	Megger / Baur Inst.	Nos.	5
12	Multifunction calibrator	Megger / Scope / Baur Inst. / Cloutek / RPP / Elmack,	Nos.	2
13	Digital milliohm meter upto 2000 mohm	Rishab / Fluke / Metravi / Biddle / AVO / Megger,	Nos.	2
14	Digital Multimeter	Megger / Scope / Baur Inst. / Keysight Technologies / Fluke / AVO	Nos.	4
15	Primary injection test kit	Megger / Scope / Baur Inst. / Biddle / AVO	No.	1
16	Portable digital insulation tester 5KV	Megger / Scope / Fluke / PCI Ltd. / Biddle	No.	1
17	Digital low resistance ohmmeter	Scope / Motwane / Argonic / Biddle / AVO / Megger / Fluke	No.	1
18	Universal relay test kit, 3 channel	Freza 300 / Omicron 356 / Double / Megger	No.	1
19	3 phase portable Transformer turn ratio & Vector group meter	Scope / Megger / AVO / Seba / Doble,	No.	1
20	Secondary injection test set, 120A	Programma Serverkar 760 / N \ Baur Inst.	No.	1
21	12KV Automatic capacitance & tanδ test kit (Schering Bridge) with oil resistivity test cell	Omicron CPTD1 / Eltel / Baur Inst. / Doble / Megger / Biddle	No.	1
22	Portable Circuit Breaker Motion Analyser	Scope / PCI Ltd. / Programma / Baur Inst.	No.	1

27. TESTING & MAINTENACE EQUIPMENT

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

27.1. SF6 Gas leakage detector.

The detector shall be portable, battery operated, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The sensor shall be connected through a flexible wand for easy accessibility to joints, seals and couplings in GIS equipment and provided with a protection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard. The test kit shall be compatible for EMI/EMC environment as per IEC 1000.

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

- 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).
- 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.
- 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

- 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.

  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

27.3. SF6 gas analyzer:

The SF6 gas analyser should be of portable type and instruments shall have following features:

a. In-built calibration facility.
b. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.

c. Equipment shall work on zero gas loss principle i.e. gas should be pumped back to the compartment after measurement without any exposure to the atmosphere.

d. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.

e. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376

i) SF6 purity – Range: 0-100 % & Accuracy: +/- 2 deg

ii) Dew point - Range : -60 to +20 deg C & Accuracy: +/- 4 deg C

iii) SO2 - Range : 0-150 ppm & Accuracy : +/- 2 %

iv) HF - Range : 0-10ppm & Accuracy : +/- 10 %

f. Instrument should work on AC source as well as on rechargeable battery

g. Input pressure: upto 10 bar

h. It should be housed in a robust IP67 case with wheels

27.4. Portable Partial Discharge(PD) monitoring system (Shall generally applicable for 220kV&132 kV)

- 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.
- 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.
- 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.
- 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.

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

27.5. Online Partial Discharge Monitoring System (Applicable for 765kV& 400 kV GIS)

- 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.

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

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

16. The capacity of each detector unit to be specified to accommodate as many numbers of PD sensors signal.
17. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation has to be submitted in this regard.
18. Guaranteed technical particulars & data sheet for various components used in the system shall be submitted.

- **Calibration:** The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 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.

- **Every Day Use & Maintenance** : The system shall be designed suitable for an unmanned 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.

- **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.

- **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.

- **Self-Test (Diagnostic) Facility**: Built-in self-checking facility shall be incorporated in the 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.
- **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.
- **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.
- **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.
- **Alarm Facility:** The PDM system shall generate alarm when action is required; viz. a) PD alarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to be connected to SAS.
- **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.
- **Schematics: The** PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.
- **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.

- **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.

- **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.

- 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

- Special Tools / equipment, Spare Parts, software packages

  Special Tools: Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.

  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.

  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.

  Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

- 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.

- **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.

- 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.

ANNEXURE_BOQ_765kV_GIS, Rev.1 (dated 18 Oct 2023)

SL	DESCRIPTION	UNIT	QTY	REMARKS
1	SUPPLY- GIS : 765KV, 50KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS			
1.01	765KV SF6 GIS GENERATOR TRAFORMER BAY	Set	3	3
1.02	766 KV, SF6 GIS ICT BAY	Set	2	2
1.03	765 KV, SF6 GIS LINE FEEDER BAY WITH PIR	Set	5	
1.04	765 KV, SF6 GIS BUS REACTOR BAY	Set	1	
1.05	765KV SF6 GIS TIE BAY WITH PIR	Set	3	
1.06	765KV SF6 GIS TIE BAY WITHOUT PIR	Set	4	
1.07	765 KV, SF6 GIS LINE REACTOR BAY	Set	2	
1.08	765KV SF6 GIS AUXILIARY BUSBAR MODULE FOR SPARE LINE REACTOR	Set	1	
1.09	765KV GIS BUS BAR MODULE AS PER SLD & TENCHNICAL SPECTIFCATION	Set	2	
1.10	765KV GIS BUS MEASUREMENT BAY INCLUDING LA, VT, DS & ES AS PER SLD & TENCHNICAL REQUIREMENT	Set	2	
1.11	PROVISION FOR FUTURE SWITCHABLE LINE REACTOR BAY INCLUDING INTERFACING MODULE AND EXTENDED MAIN BUS FOR INTERFACING	Set	2	ASSOCIATED WITH LINES SUNDARGARH SS LILO-01 & SUNDARGARH SS LILO-02

SL	DESCRIPTION	UNIT	QTY	REMARKS
1.12	765KV SF6 GIS ADAPTER BOX FOR EXTENSION OF GIS, SET OF 3 PHASE: END PIECE / INTERFACE MODULE WITH THE TEST LINK FOR FUTURE EXTENSION OF MAIN GIS BUSBAR / GIB	Set	4	
1.13	765KV SINGLE PHASE, SF6 GAS INSULATED BUS DUCT (GIB) OUTSIDE GIS HALL ALONGWITH ASSOCIATED SUPPORT STRUCTURE & EARTHING	Meter	6500	
1.14	765KV SF6 TO AIR BUSHING (1 PHASE)	Nos.	45	
1.15	SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION	Lot	1	
1.16	CONTROLLED SWITCHING DEVICE FOR 765 KV, 3-PH CIRCUIT BREAKER	Set	13	
1.17	LOCAL CONTROL CUBICLES (LCC)	Nos.	20	
1.18	STRUCTURE MATERIAL INCLUDING ANCHOR BOLTS, EMBEDDED ITEMS, RAILS AND/ OR OTHER MATERIALS ETC.	Lot	1	
1.19	EARTHING MATERIALS INCLUDING HIGH FREQUENCY EARTHING	Lot	1	
1.20	ONLINE PARTIAL DISCHARGE MONITORING SYSTEM FOR 765KV GIS.	Set	1	On line partial discharge (PD) monitoring system as per IEC60270 shall be envisaged for monitoring. The number and location of these sensors shall be based on the laboratory test on typical design of GIS as per IEC recommendation of CIGRE Document No 654. (Application for sensitivity verification for PD detection system for GIS).

SL	DESCRIPTION	UNIT	QTY	REMARKS
1.20	CONTINUOUS ONLINE PARTIAL DISCHARGE MONITORING SYSTEM FOR 765KV GIS.	Set	1	On line partial discharge (PD) monitoring system as per IEC60270 shall be envisaged for **continuous monitoring.** The number and location of these sensors shall be based on the laboratory test on typical design of GIS as per IEC recommendation of CIGRE Document No 654. (Application for sensitivity verification for PD detection system for GIS).
1.21	SF6 GAS PROCESSING UNIT	Set	1	
1.22	SF6 GAS LEAKAGE DETECTOR	Set	1	
1.23	BREAKER TEST KIT	Set	1	
1.24	CONTACT RESISTANCE MEASUREMENT SET SUITABLE FOR MICRO OHMS	Set	2	
2	SPARES- GIS : 765KV, 50KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS			
2.01	SPARE - O-RING AND GASKETS (ONE OF EACH TYPE & SIZE)	Set	3	
2.02	SPARE - SF6 GAS PRESSURE RELIEF DEVICES (ONE OF EACH TYPE & RATING ALONG WITH Ó'RINGS)	Set	2	
2.03	SPARE - SF6 GAS CYLINDER (20% OF TOTAL QUANTITY)	Set	1	
2.04	SPARE - MOLECULAR FILTER FOR SF6 GAS WITH FILTER BAGS (5% OF TOTAL QUANTITY)	Set	1	
2.05	SPARE - ALL TYPES OF CONTROL VALVES FOR SF6 (ONE OF EACH TYPE & RATING)	Nos.	3	

SL	DESCRIPTION	UNIT	QTY	REMARKS
2.06	SPARE - LOCKING DEVICE TO KEEP THE DISCONNECTORS /ISOLATORS AND EARTHING SWITCHES IN CLOSE OR OPEN POSITION IN CASE OF REMOVAL OF DRIVING MECHANISM	Nos.	3	
2.07	SPARE - SPARES FOR LOCAL CONTROL CABINET INCLUDING MCB, FUSES, TIMER, AUXILIARY RELAYS, CONTACTORS, PUSH BUTTONS, SWITCHES, LAMPS & ANNUNCIATION WINDOWS, TERMINAL BLOCKS (ONE OF EACH TYPE & RATING, SIZE, RATING & MAKE)	Nos.	2	
2.08	SPARE - SF6 TO AIR BUSHING COMPLETE WITH CONNECTORS (ONE OF EACH TYPE & RATING & RATING)	Nos.	1	
2.09	SPARE - SINGLE PHASE POTENTIAL TRANSFORMER (ONE OF EACH TYPE & RATING, ACCURACY CLASS, BURDEN)	Set	1	
2.1	SPARE - SINGLE PHASE CURRENT TRANSFORMER (ONE OF EACH TYPE & RATING, RATIO, ACCURACY CLASS, BURDEN) WITH ASSOCIATED ENCLOSURE AND PRIMARY CONDUCTOR COMPLETE IN ALLRESPECT	Set	1	
2.11	SPARE - EXPLOSION VENT DIAPHRAGMS (5% OF TOTAL POPULATION)	Set	1	
2.12	SPARE - BUS SUPPORT INSULATOR (5% OF TOTAL POPULATION)	Set	1	
2.13	SPARE - SURGE ARRESTOR (ONE OF EACH TYPE & RATING & RATING AND DISCHARGE CLASS)	Nos.	1	
2.14	SPARE - SURGE COUNTER WITH LEAKAGE CURRENT MONITOR	Nos.	1	
2.15	SPARE - 765 KV CIRCUIT BREAKER (BELOW LIST SHALL BE PROVIDED FOR 765 KV CIRCUIT BREAKER)			
2.15.1	CB SPARE - COMPLETE POLE ASSEMBLY (1 PHASE) OF CIRCUIT BREAKER OF EACH TYPE AND RATING COMPLETE WITH INTERRUPTER, MAIN CIRCUIT, ENCLOSURE, MARSHALLING BOX WITH OPERATING MECHANISM (APPLICABLE FOR CB WITHOUT PIR)	Set	1	
2.15.2	CB SPARE - COMPLETE POLE ASSEMBLY (1 PHASE) OF CIRCUIT BREAKER OF EACH TYPE AND RATING COMPLETE WITH INTERRUPTER, MAIN CIRCUIT, ENCLOSURE, MARSHALLING BOX WITH OPERATING MECHANISM (APPLICABLE FOR CB WITH PIR)	Set	1	
2.15.3	CB SPARE - CIRCUIT BREAKER CLOSING AND OPENING COIL ASSEMBLY (ONE OF EACH TYPE & RATING)	Set	2	

SL	DESCRIPTION	UNIT	QTY	REMARKS
2.15.4	CB SPARE - CIRCUIT BREAKER OPERATING MECHANISM (ONE OF EACH TYPE & RATING)	Set	1	
2.15.5	CB SPARE - CIRCUIT BREAKER OPERATION COUNTER (ONE OF EACH TYPE & RATING)	Nos.	3	
2.15.6	CB SPARE - AUXILIARY SWITCH ASSEMBLY (ONE OF EACH TYPE & RATING)	Nos.	3	
2.16	765 KV ISOLATOR / DISCONNECTOR, EARTH SWITCHES (BELOW LIST SHALL BE SEPARATELY PROVIDED FOR 765 KV GIS)			
2.16.01	SPARE - COMPLETE SET OF 3 NOS. OF SINGLE PHASE / ONE 3 PHASE ISOLATOR OF EACH TYPE , DIMENSION, CURRENT, & VOLTAGE RATING INCLUDING MAIN CIRCUIT, ENCLOSURE, DRIVING MECHANISM	Set	1	
2.16.02	SPARE - 3 NOS OF SINGLE PHASE / ONE 3 PHASE MAINTENANCE EARTH SWITCH OF EACH TYPE , DIMENSION, CURRENT, & VOLTAGE RATING INCLUDING MAIN CIRCUIT, ENCLOSURE, DRIVING MECHANISM	Set	1	
2.16.03	SPARE - 3 NOS OF SINGLE PHASE / ONE 3 PHASE FAST ACTING EARTH SWITCH OF EACH TYPE , DIMENSION, CURRENT, & VOLTAGE RATING INCLUDING MAIN CIRCUIT, ENCLOSURE, DRIVING MECHANISM	Set	1	
2.16.04	SPARE - OPEN & CLOSE CONTACTOR ASSEMBLY INCLUDING TIMER, INTERLOCKING COILS, KEY INTERLOCK, RELAYS, PUSH BUTTONS, INDICATING LAMPS, POWER CONTACTORS, RESISTER, FUSES, MCB FOR ONE COMPLETE DISCONNECTOR (3 PHASE) (ONE OF EACH TYPE & RATING)	Nos.	1	
2.16.05	SPARE - OPEN & CLOSE CONTACTOR ASSEMBLY INCLUDING TIMER, INTERLOCKING COILS, KEY INTERLOCK, RELAYS, PUSH BUTTONS, INDICATING LAMPS, POWER CONTACTORS, RESISTER, FUSES, MCB FOR ONE COMPLETE MAINTENANCE EARTH SWITCH (3 PHASE) (ONE OF EACH TYPE & RATING)	Nos.	1	
2.16.06	SPARE - OPEN & CLOSE CONTACTOR ASSEMBLY INCLUDING TIMER, INTERLOCKING COILS, KEY INTERLOCK, RELAYS, PUSH BUTTONS, INDICATING LAMPS, POWER CONTACTORS, RESISTER, FUSES, MCB FOR ONE COMPLETE FAST ACTING EARTH SWITCH (3 PHASE) (ONE OF EACH TYPE & RATING)	Nos.	1	
2.16.07	SPARE - ISOLATOR CONTACTS (ONE OF EACH TYPE & RATING & CURRENT RATING)	Set	1	

SL	DESCRIPTION	UNIT	QTY	REMARKS
2.16.08	SPARE - MAINTENANCE EARTH SWITCH CONTACTS (ONE OF EACH TYPE & RATING & CURRENT RATING)	Set	1	
2.16.09	SPARE - FAST ACTING EARTH SWITCH CONTACTS (ONE OF EACH TYPE & RATING & CURRENT RATING)	Set	1	
2.16.1	SPARE - ISOLATOR OPERATING MECHANISM (ONE OF EACH TYPE & RATING)	Nos.	3	
2.16.11	SPARE - MAINTENANCE EARTH SWITCH OPERATING MECHANISM (ONE OF EACH TYPE & RATING)	Nos.	3	
2.16.12	SPARE - FAST ACTING EARTH SWITCH OPERATING MECHANISM (ONE OF EACH TYPE & RATING)	Nos.	3	
2.16.13	SPARE - LIMIT SWITCH ASSEMBLY FOR DISCONNECTOR (ONE OF EACH TYPE & RATING)	Set	2	
2.16.14	SPARE - LIMIT SWITCH ASSEMBLY FOR MAINTENANCE EARTH SWITCH (ONE OF EACH TYPE & RATING)	Set	2	
2.16.15	SPARE - LIMIT SWITCH ASSEMBLY FOR FAST ACTING EARTH SWITCH(ONE OF EACH TYPE & RATING)	Set	2	
2.17	SPARE - STATIC FILTER(ADSORBENT) (5% OF TOTAL POPULATION)	Set	1	
2.18	SPARE - GAS BARRIER & RUPTURE DISK (ONE OF EACH TYPE & RATING) (5% OF TOTAL POPULATION)	Set	1	
2.19	SPARE - GAS DENSITY MONITOR (PRESSURE SWITCH WITH GAUGE) (5% OF TOTAL POPULATION)	Set	1	
2.2	SPARE - COUPLING DEVICES ONE OF EACH TYPE & RATING OF PRESSURE GAUGE CUM SWITCH FOR CONNECTING GAS HANDLING PLANT	Set	2	
3	SPARES- GIS : REFERENCE UNIT PRICE FOR ADDITION / DELETION OF SUPPLY ITEMS: (Unit Prices of Individual Equipment included here or in manadatory spares are required for any Addition/Deletion of Equipment and replacement of damaged items. 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)			
3.1	ADDITION / DELETION OF 1 PHASE 1 CORE GIS CURRENT TRANSFORMER (IF REQUIRED IN DETAILED ENGINEERING)	Set	12	
3.2	ADDITION / DELETION OF 1 PHASE 1 CORE / WINDING GIS VOLTAGE TRANSFORMER (IF REQUIRED IN DETAILED ENGINEERING	Set	6	
4	SERVICES- GIS : 765KV, 50KA FOR 1S, GAS INSULATED SWITCHGEAR (GIS) AS PER TS			

SL	DESCRIPTION	UNIT	QTY	REMARKS
4.01	SERVICES- GIS : 765KV, SUPERVISION OF ERECTION OF GIS	Lot	1	Supervision of erection of 765kV GIS, complete in all respect including LCC. It also includes supervision of unloading & verification of materials for proper storage at site. In the event of changes in scope, payment shall be made on pro-rata basis of circuit breaker bays only. This includes services for complete GIS system excluding GIB & SAB.
4.02	SERVICES- GIS : 765KV, SUPERVISION OF ERECTION OF GAS INSULATED BUS DUCT	Set	1	
4.03	SERVICES- GIS : 765KV, SUPERVISION OF ERECTION OF SF6 TO AIR BUSHING	Set	45	Single phase SF6 Bushing.
4.04	SERVICES- GIS : 765KV, TESTING & COMMISSIONING OF GIS	Lot	1	Testing and commissioning of complete 765kV GIS system is to be executed by contractor (excluding HV Test which is covered in a separate line item below). 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. (This also includes Testing & commissioning of GIB, SAB & CSD etc complete in all aspect)
4.05	SERVICES- GIS : 765KV, 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 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.
4.06	SERVICES- GIS : STUDIES INSULATION CO-ORDINATION VFTO REPORT e.t.c. complete	Lot	1	Complete study as per technical specification
4.07	SERVICES- GIS : TRAINING AT GIS FACTORY	Days	2	

SL	DESCRIPTION	UNIT	QTY	REMARKS
4.08	SERVICES- GIS : TRAINING AT SITE	Days	2	
5	SERVICES- GIS : REFERENCE UNIT PRICE FOR ADDITION / DELETION OF SERVICES: (UNIT PRICES OF INDIVIDUAL SERVICES INCLUDED HERE ARE REQUIRED FOR ANY ADDITION/DELETION OF EQUIPMENT AND REPLACEMENT OF DAMAGED ITEMS. VENDOR TO ENSURE THAT THE UNIT PRICES HAVE A LOGICAL RELATIONSHIP WITH PRICES OF ASSEMBLIES IN MAIN ITEMS. QUOTING FOR UNIT PRICES IS MANDATORY AND SHALL BE CONSIDERED FOR EVALUATION)			
5.1	SERVICES- GIS : REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR SUPERVISION OF ERECTION OF GIS	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.
5.2	SERVICES- GIS : REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR TESTING & COMMISSIONING OF GIS	MANDAY	10	Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.
5.3	SERVICES- GIS : 765KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - 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 commissioning of GIS. (if required due to reasons not attributed to the contractor)

SECTION-2

GENERAL PROJECT INFORMATION

2.0.0 GENERAL PROJECT INFORMATION

<table>
<tr><td>1</td><td>Owner / Purchaser</td><td>NLC India Limited (NLCIL)</td></tr>
<tr><td>2</td><td>Thermal Power Station</td><td>NLC Talabira Thermal Power Project</td></tr>
<tr><td>3</td><td>Capacity and Configuration</td><td>2400 MW [3 x 800 MW]</td></tr>
<tr><td>4</td><td>Owner’s Consultant for Section B scope of work</td><td>Development Consultants Private Limited</td></tr>
<tr><td>5</td><td>Geographical Location</td><td>
<table>
<tr><th>Description</th><th>Latitude</th><th>Longitude</th></tr>
<tr><td>North Extreme</td><td>21° 46’ 56.11’’ N</td><td>83° 59’ 30.59’’ E</td></tr>
<tr><td>East Extreme</td><td>21° 46’ 52.95’’ N</td><td>84° 00’ 20.72’’ E</td></tr>
<tr><td>South Extreme</td><td>21° 45’ 16.80’’ N</td><td>83° 59’ 9.36’’ E</td></tr>
<tr><td>West Extreme</td><td>21° 46’ 34.18’’ N</td><td>83° 58’ 50.54’’ E</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Access to site</td><td></td></tr>
<tr><td>6.1</td><td>Nearest Airport</td><td>Bhubaneswar at a distance of 350 km and Raipur airport is at a distance of approx. 290 km.</td></tr>
<tr><td>6.2</td><td>Nearest sea port</td><td>Paradeep (Approx. 450 km) and Kolkata (Approx. 550 km)</td></tr>
<tr><td>6.3</td><td>Nearest Railway Station</td><td>Nearest railway station at Jharsuguda on Howrah-Nagpur main (trunk) section is at a distance of 11 km.</td></tr>
<tr><td>6.4</td><td>Nearest Town</td><td>Jharsuguda (approx. 11 km)</td></tr>
<tr><td>6.5</td><td>Nearest Highway</td><td>Sambalpur – Jharsuguda highway</td></tr>
<tr><td>7</td><td>Meteorological data</td><td></td></tr>
<tr><td>7.1</td><td>Site Elevation</td><td>Average level of elevation is 203 M above MSL.</td></tr>
</table>

TABLE-VIII

DESIGN SITE AMBIENT CONDITIONS

Description	Data
Mean Ambient temperature (ºC)	33.1 (maximum) 20.7 (minimum) 27.5 (average)
Extreme Ambient Temperature (ºC)	48.0 (maximum) 6.0 (minimum)
Mean Ambient Wet-bulb Temperature (ºC)	26.3
Mean Relative Humidity (%)	66 (at 8.30 hrs) 50 (at 17.30 hrs)
Annual Rainfall (mm/year)	1445.0
Wind Load	In accordance with IS-875, for a basic wind speed of 44 m/s, up to a height of 10 meters above mean ground level
Seismic Zone	Zone III as per IS:1893 latest edition.
Altitude	202.5 m above MSL

7.2	Mean Ambient Temperature	
i.	Maximum	33.1 ºC
ii.	Minimum	20.7 ºC
iii.	Average	27.5 ºC
7.3	RELATIVE HUMIDITY	
i.	At 8.30 hrs	66 %
ii.	At 17.30 hrs	50 %
7.4	Earthquake Zone	Zone III as per IS-1893
7.5	Predominant Wind direction	From South-West
7.6	Wind velocity	Civil/structural design will be done as per IS 875 for a basic wind speed of 44 m/sec upto a height of 10 M from ground level
7.7	Rainfall	
i.	Annual average	1445 mm
7.8	Availability of Raw Water	From Hirakud reservoir through Intake pump house to Plant raw water reservoir

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VOLUME: II-F/2

SECTION-XII

765KV, 400KV & 33KV GAS INSULATED SWITCHGEAR (GIS)

CONTENTS

VOLUME: II-F/2

SECTION-XII

765KV, 400KV & 33KV GAS INSULATED SWITCHGEAR (GIS)

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works before dispatch, shipping, complete and efficient erection, testing, commissioning and putting into successful commercial operation of factory assembled, metal-enclosed, SF6 Gas Insulated Switchgear and SF6 gas-insulated bus duct as specified hereunder. The GIS configuration shall be based on drawings & SLD enclosed. The switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power & control wiring, grounding connections, gas monitoring equipment & piping, on-line partial discharge monitoring system, support structures, necessary firefighting arrangement, ventilation & air conditioning equipment, EOT crane etc.

1.02.00 All items of equipment and system covered under this specification shall be complete in all respect and any item of equipment or accessory not specifically mentioned in this specification but considered essential for efficient and satisfactory operation of individual equipment and system as a whole shall be included in the offer.

1.03.00 The equipment shall conform in all respect to high standards of engineering design and workmanship and should be capable of performing continuous commercial operation within the parameters guaranteed.

1.04.00 Standard designs are preferred provided they meet the requirements of this specification and serve the intended purpose. Alternative design may be offered if the same provides substantial technical improvements or economic advantages. However, it will be at the discretion of the Owner to accept such alternative proposed design. All equipment are intended for continuous duty at the specified ratings without forced cooling under the specified climatic conditions, unless otherwise specified.

2.00.00 SCOPE OF WORK

2.01.00 **Scope of Supply – Electrical**

2.01.01 The scope of supply includes design, manufacture, assembly, testing at manufacturer's works, delivery to site, storing at site of Gas Insulated Switchgear with all accessories as detailed in the following accompanying specification and as required.

2.02.00 765KV, 400KV & 33KV GIS

2.02.01 765KV 400KV & 33KV GIS comprise the following major components:

A. The 765KV GIS shall have following Bays / Dias:

i) GT Bays : 3

ii) ICT Bays : 2 of (765 / √3) / (400/ √3) / 33kV Inter Connecting Transformer (ICT) feeders

~~iii) Line Bays with switchable reactors : 4~~

iv) Bus-reactor Bay : 1

v) Adapter box for extension of GIS

vi) Space for one (1) Dia of future GT -4 Bay

vii) Spare feeder bay with switchgears.

Apart from above there will be two (2) bus PTs.

(iii) Line bays with switchable reactors -2
Line bays without switchable reactors -2

All the Bays shall have its own individual Local Control Cubicle (LCC).

B. The 400KV GIS shall have following Bays / Dias:

i) ICT Bays : 2

ii) ST Bays : 3

iii) Line Bays : 3 (including 1 spare line feeder)

iv) Bus-reactor Bay : 2

v) Inter Bus Transformer Bay : 2

vi) Spare feeder bay with switchgears.

vi) Adapter box for extension of GIS

vii) Space for one (1) Dia of future feeder

Apart from above there will be two (2) bus PTs.

All the Bays shall have its own individual Local Control Cubicle (LCC).

C. The 33KV GIS shall have following panels

i) Incomer from Transformer : 2

ii) Outgoing Feeder : 6 (2 nos. for Intake Pump House, 2 nos. for Township, 2 Nos. for Mines)

iii) 2 nos. spare feeders.

iv) 1 no. bus coupler

Apart from above there will be two (2) bus PTs.

D. The 765kV & 400kV GIS shall employ bus configuration with One and half ($1^1/_2$) breaker scheme, whereas 33kV GIS shall employ single bus configuration (Two incomer with bus coupler scheme)

E. Numerical relay panels and bay controllers.

F. Lightning arrestors, Bus Post Insulators (if required), etc. with supporting structures in Switchyard area and transformer yard area.

G. Gantries, overhead conductor to connect 765KV, 400KV & 33KV line, GT and ST.

H. Gas insulated busduct with SF6 to air bushings near Gantries

I. Power line carrier communication system

J. Wave Traps (for floor mounting, civil foundation for the same shall be provided in all the three phases), tariff CTs, tariff CVTs for outgoing lines.

Metering panels with ABT energy meters and necessary hardware and software suitable for ABT scheduling / information / monitoring. Necessary erection and wiring shall be covered in the scope of this bidder. ABT monitoring system repeater HMI shall be provided at Main control room for Generation scheduling by shift Engineer. Requirement of ABT scheme scheduling and monitoring scheme shall be finalized during detailed Engineering.

Main & check ABT metering Separate Outdoor CTs &CVTs shall be provided for outgoing line , One separate CT & PT core for Third ABT Metering inside the GIS shall be provided for line .

One Metering CT & PT core for Main & Check ABT metering and One separate CT&PT core for Third ABT metering of GT, ST, ICT, IBT, Reactors shall be provided inside the GIS.

K. Intermediate gantry near GIS hall inside Switchyard Fence and interconnection to these intermediate gantries from SF6 to Air Bushing. Stringing arrangement of EHV ACSR conductors from gantries / towers located in transformer yard near transformers up to intermediate gantry located at switchyard area along with the required jumpering at the intermediate gantry in switchyard area shall be in Bidder's scope.

L. Earth mat below ground level and earthing of equipment

M. PLCC panels (To be supplied at both ends for matching).

N. Overhead crane of suitable size in GIS room

O. Complete illumination system

P. Air-conditioning and ventilation equipment

Q. Fencing

R. OPGW system

PIR CSD
B P S

S. S) 765kV Circuit breakers of line bays shall be provided with PIR, Also circuit breakers (765kV & 400kV) for GT, ST, ICT and Reactors shall be provided with CSD (Controlled switching device).CSD Shall be provided for Tie breakers of associated GT,ST,ICT and Reactor bays

T. Online partial discharge monitoring system for 765KV & 400 kV GIS.

U. Control and Relay Panel may be located either inside switchyard control building or as annex building to GIS Building.

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2.03.00 The following equipment are to be considered but not be limited for each GIS module:

a) Circuit breaker
b) Disconnect switch
c) Maintenance earth switch
d) Fast acting earth switch
e) Bus earthing switch
f) Voltage transformer
g) Current transformer
h) Bus and elbow section
i) SF6 to air bushing
j) Surge arrestor with counter – communicable type (if required)
k) Ground connection to the station grid
l) Auxiliary material to complete the GIS installation (like density switches, secondary cables, bolts etc.)
m) Insulating SF6 gas
n) Local control cubicle (LCC)

2.04.00 The hardware, materials & miscellaneous items related to 765KV & 400KV GIS & Lines shall include but not limited to the following:

a) ACSR conductors (Bersimis / Bull / Moose / Zebra), lightning mast and shielding wires
b) Grounding rods, flats, wires, ground mat below one meter, risers
c) Tension insulator string assembly sets
d) Suspension insulator string assembly sets.
e) Conductor spacers, clamps & connectors, sag compensators

f) Lightning protection materials

g) IPS aluminium tube

h) Substation Automation System

i) Two (2) sets each of 220V and 48V, lead acid plante type battery with 1x100% float charger and 1x100% float cum boost chargers for each set of battery connected to a DCDB. DC system shall be supplied as per the requirements mentioned in the specification of battery and battery charger

j) One set of redundant 220V AC UPS.

k) Auxiliary power distribution board (AC & DC)

l) SF6 gas handling equipment

m) SF6 gas leakage detector

n) Testing and measuring equipment

o) Disturbance recorder & event loggers

p) Power, control and communication cables along with cable trenches, racks, supports, cable trays and accessories

q) All associated civil and structural works including 765KV, 400KV & 33KV GIS building, switchyard control room, lattice structures, gantry, equipment structure / foundations, switchyard fencing etc.

r) All related mechanical items including air conditioning system for switchyard control room, exhaust ventilation & crane for 765KV, 400KV & 33KV GIS buildings, etc.

EOT Crane for each GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipment.

2.05.00 All relevant drawings, data and instruction manuals.

2.06.00 Scope of Installation Work

a) The scope of installation work includes erection, testing, commissioning and putting into successful commercial operation of GIS equipment, grounding system and cabling work, lightning protections, stringing and connections, illumination system as detailed in accompanying specifications described above including supply of all labors, materials, tools, tackles etc.

b) Installation of lightning arrestors & CVTs, stringing of overhead conductors to 765KV & 400KV line terminals including supply of lightning arrestors, string insulators, spacers, connectors, hardware etc. as required for completeness of connections, stringing of overhead conductors to transformer yard gantries / towers and connection to Transformers required jumpering at the intermediate gantry in switchyard area shall be in Bidder's scope.

c) Installation of Spare Single phase GT, Single phase ICT& Single phase Reactor including foundation, rail arrangement , oil pit and associated civil works.

d) Spare Single phase GT, Single phase ICT & Single phase Reactor shall be energized through MV power supply (11/33kV)

e) Furnishing, mounting & wiring of all equipment, device and accessories.

2.07.00 Scope of Services

a) Providing all labor, skilled & unskilled, supervisory personnel, erection tools & tackles, testing equipment, implements, supplies and transport for timely and efficient execution of the erection work.

b) The items of work to be included under the scope of services of the contractor as specified below:

i) Erection, Testing & commissioning of all GIS modules with all fittings and accessories supplied under this contract

ii) Erection, Testing & commissioning of all AIS equipment (Tariff CT, Tariff CVT, Surge Arrestor, Wave Trap, etc.)

iii) Substation automation system with bay controllers, relay panels.

iv) Erection testing commissioning of PLCC panels including handing over of other end PLCC panel to remote end SS. Provision to be made by bidder for real time data transfer to LDC through two different route. Coordination in commissioning of PLCC and FOTE system at both ends of outgoing lines.

v) Auxiliary power distribution board (A.C & D.C)

vi) DC system, UPS system

vii) Illumination system

viii) Erection, testing & commissioning of insulators, busbars, clamps & connectors, hardware etc.

ix) Stringing and connection to ACSR conductor & shield wire supplied under this contract.

x) Laying, termination, testing & commissioning of power and control cable and ADSS fiber optics cables supplied under this contract.

xi) Installation, testing & commissioning of grounding and lightning protection materials for grounding of all equipment, cable trench/tray, tower, gantry, structure, fencing etc.

xii) Erection, testing & commissioning of pre-fabricated cable trays with all accessories supplied under this contract.

xiii) Fabrication & installation of tower, gantry & structure, fence supports, fence, etc. supplied under this contract.

xiv) Laying of earth material and equipment including risers, earthing of all SAS equipment & numerical relays bay controllers by using separate electronic earth pits.

xv) Laying of 150mm thick, 20mm gravel and spray of anti-weed powder/chemical.

c) All testing equipment as required for testing & commissioning of equipment/system shall be arranged by the bidder.

d) Switchyard control room shall be provided as indicated in plot plan

e) Proposed SCADA shall be suitable for accommodating Stage -1 and stage-2 (Future) bays

f) 220V DC system

g) Decentralized Bus Bar protection.

h) Below ground earthing shall be provided for complete GIS building including Stage-2 space provision area.

i) The bidder shall also carry out the following services but not be limited to:-

i) Repair of all minor damages such as removal of paint, loosening of components of the assembly etc.

ii) Complete assembly, erection and commissioning

iii) Pre-commissioning check up to ensure correctness of erection as per actual manufacturer instructions

iv) Testing and commissioning in presence of Owner's engineers

v) Obtaining engineer's approval and written acceptance of satisfactory operation

vi) Handing over of installation for commercial operations

vii) Preparation and submission of drawings & job compliance report and obtaining drawing approval and charging permission from the electrical inspectorate for GIS substations.

3.00.00 CODES AND STANDARDS

3.01.00 The entire scope of work shall be carried out in accordance with established engineering practice and in conformity to this specification and with the relevant specifications and codes of practice of the Indian standards.

3.02.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification. In addition, work shall also conform to the requirements of the following:

a) IS: 10118-1982: Code of Practice for Selection, Installation and Maintenance of Switchgear and Control gear – Part-3 (Installation)

b) Central Board Irrigation & Power (CBIP, New Delhi–India) Technical Manual on Layout of Substation, Report No. 3

c) Indian Electricity Act and rules framed there under

d) Fire insurance regulations

e) Any other regulations laid down by Central/State/Local authorities during the execution of this Contract.

3.03.00 **Performance, Standards and Codes for GIS**

Performance, testing and rating of the switchgear shall conform to the latest edition of the following IEC & other publications, which are in addition to those indicated in Section I of Vol. II-F1 :

IEC62271-1	Common clause for HV switchgear and control gear
IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above 52 KV
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 62271-100	A.C. High Voltage alternating current circuit breakers
IEC 62271-102	A.C. disconnectors and earthing switches
IEC 61869	Current and Voltage transformers
IEC 60099–4	Metal - Oxide Surge arresters without gaps for A.C. system
IEC 60137	Bushings for alternating voltages above 1000V
IEC 60376	SF_6 gas / Use and handling of SF_6
IEC 62271-102.	A.C. Disconnectors' bus transfer current switching by disconnectors.
IEC 60480	Guide to the checking of SF6 taken for electrical Equipment
IEC 60060	High voltage test techniques
IEC 60071	Insulation Coordination
IEC 60255	Electrical Relays
IEC 62271	High Voltage switches

IEC 60270	Partial Discharge measurement
IEC 60529	Degree of protection
IEC 60815	Pollution levels
IEC 62271-209	Cable connections for GIS
IEC 61000	Electromagnetical compatibility (EMC)
ANSI/IEEE 80	Guide for safety in A.C. substation grounding
CIGRE-44	Earthing of GIS- an application guide. (Electra no.151,Dec'93
CENELEC /SVDB	Pressure vessel codes
IEC 61639	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above. Compliance of the switchgear manufacturer with the provisions of this specification does not relieve him of the responsibility of furnishing switchgear and accessories of proper design, electrically and mechanically suited to meet the operating guarantees at the specified service conditions.

CURRENT TRANSFORMERS

IS 2705	Current transformers
Part 1 – 1992	General Requirements (Second Revision)
Part 2 – 1992	Measuring current transformers (Second Revision)
Part 3 – 1992	Protective current transformers (Second Revision)
Part 4 – 1992	Protective current transformers for special purpose applications (Second Revision)
IS 4201 – 1983	Application guide for current transformers (First Revision)
IS 6949 – 1973	Summation current transformers

VOLTAGE TRANSFORMERS

IS 3156	Voltage Transformers
Part 1 – 1992	General requirements (Second Revision)
Part 2 – 1992	Measuring voltage transformers (Second Revision)
Part 3 – 1992	Protective voltage transformers (Second Revision)
Part 4 – 1992	Capacitor voltage transformers (Second Revision)
IS 4146 – 1983	Application guide for voltage transformers (First Revision)
IS 5547 – 1983	Application guide for capacitor voltage transformers (1st Rev)
IEC 60044-2	Voltage Transformers

LIGHTNING ARRESTORS

IS 3070 Part 3-1993	Lightning arrestors for alternating current systems Metal Oxide surge arresters with gap

TRANSFORMER & REACTOR

IS No.	TITLE	IEC/BS/NEMA No.
IS: 2026	Power transformers	IEC: 60076
IS:5553 Part-I	Shunt Reactors	IEC: 60289
IS: 3639	Fittings & accessories for power transformers	
	Insulating oil for transformers and switchgear	IEC: 60296, BS:148
IS: 2099	Bushing for alternating voltages above 1000V	IEC: 60137, BS: 223
IS: 2705	Current transformers	IEC: 60044-1
IS: 375	Marking & arrangement for switchgear bus bars, main connections & auxiliary wiring	
IS: 3637	Gas operated relays	
IS: 10028	Code of practice for selection, installation & maintenance of transformers	
IS: 4691	Degree of protection provided by enclosure for rotating electrical machinery	
IS: 13947	Degree of protection provided by enclosure for low voltage switchgear & control	IEC: 60144
IS : 5	Colors for ready mix paints	
IS: 1866	Code of practice for maintenance & Supervision of mineral insulating oil in equipment	
IS: 6600	Guide for Loading of oil immersed transformers	IEC: 60354
IS: 320	Code of practice for climatic proofing of Electrical equipment	
IS: 3347	Specification for dimensions of porcelain bushing	
	High voltage test technique	IEC: 60060
	Insulation co-ordination	IEC: 60071
	NEMA standard publication for Power transformers	NEMA-TR-1
IS: 9434	Guide for sampling & analysis of free & dissolved gas & oil from oil filled electrical equipment	IEC: 60567
IS: 12676	Dimensions for OIP insulated condenser bushings	

SWITCH GEAR, CONTROL GEAR, ISOLATORS, FUSES & METERS

IS 9920	Switches & Switch isolators for voltage above 1000V
Part 1-2002	General and definitions
Part 2-2001	Rating
Part 3-1982	Design and construction
Part 4-1985	Type tests & Routine tests
IS 9921	Alternating current disconnectors (isolators) and earthing switches for voltages above 1000v

Part 1-1981	General and definitions
Part 2-1982	Rating
Part 3-1982	Design and construction
Part 4-1985	Type tests & Routine tests
Part 5-1985	Alternating Current disconnectors
IS 10118-1982	Code of practice for selection, installation and maintenance of switch gear and control gear
Part 1-1982	General
Part 2-1982	Selection
Part 3-1982	Installation
Part 4-1982	Maintenance
IS 11353-1985	Guide for uniform system of marking and identification of conductors and operative terminals
IS 12063-1987	Classification of degrees of protection provided by enclosures of electrical equipment
IS 13118-1991 /IEC 56 (1987)	General requirements for circuit breakers for voltages above 1000V
IS 13703-1993	LV fuses for voltages not exceeding 1000V AC/1500V DC
Part 1-1993 / IEC 269-1 (1986)	General requirements [Superseding IS 9224 (Part 1)-1979]
Part2; Sec1-1993 /IEC 269-2 (1986)	Fuses for use by authorized persons Supplementary requirements [Superseding IS 9224 (Part 2)-1979]
Part2; Sec2-1993 /IEC 269-2 (1987)	Fuses for use by authorized persons Examples of standardized fuses
Part 4-1993 / IEC 269-4 (1986)	Supplementary requirements for fuse links for the protection of semiconductor devices [Superseding IS 9224 (Part 4)-1980
IEC-62271-102	Fast acting earth switches

POWER CABLES, CONDUCTORS & ACCESSORIES FOR OVERHEAD LINES

IS 398	Aluminium conductors for overhead transmission line
Part 1-1976	Aluminium stranded conductors (2nd Rev.) (Amendment 1)
Part 2-1996 Part 3-1976	Aluminium conductors, galvanized steel reinforced (Second Revision)
Part 4-1994	Aluminium alloy stranded conductors (aluminium magnesium silicon type) (Second Revision)
Part 5-1992	Aluminium conductors-galvanized steel reinforced for extra high voltage (400 kV & above) (First Revision)
IS 2121	Conductors and earth wire accessories for overhead power lines
Part 1-1981	Armour rods, binding wires and tapes for conductors (First Revision)
Part 2-1981	Mid Span joints & repair sleeves for conductors (First Revision)
Part 3-1992	Accessories for earth wire (First Revision)
Part 4-1991	Non tension joints (First Revision)
IS 3975-1999	Mild steel wires, formed wires and tapes for armouring of

	cables (Third Revision)
IS 5082-1998	Wrought aluminium and aluminium alloy bar rods, tubes and sections for electrical purposes (First Revision) (Amendment 1)

ELECTRICAL INSTALLATIONS – CODE OF PRACTICE AND GUIDES

1	IS 1255 – 1983	Code of practice for installation and maintenance of power cables up to and including 33 kV rating (second revision)
2	IS 3043 – 1987	Code of practice for Earthing
3	IS 5216	Guide for safety procedures and practices in electrical work
	Part 1 – 1982	General (First Revision)
	Part 2-1982	Life saving techniques (First Revision)
4	IS 5613	Code of practice for design, installation & maintenance of overhead power lines
	Part 1-1985	Lines up to and including 11 kV
	Section 1	Design (First Revision)
	Section 2	Installation and maintenance (First Revision)
5	IS 10136-1982	Code of practice for selection of disc insulator fittings for highest system voltages of 72.5 kV and above

3.04.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up-to-date, relevant IS code of Practice for respective equipment and National Electrical code of India. In addition, other rules & regulations applicable to the work shall be followed. In case of discrepancies, most restrictive rules shall be binding.

3.16.00 Guaranteed Performance

The performance figures quoted in technical particular sheets shall be guaranteed within the tolerance permitted by relevant standards. In case of failure of the equipment to meet the guarantee, the equipment may be liable for rejection.

3.06.00 Co-Ordination with Statutory Bodies and Outside Agencies

The contractor shall be fully responsible for carrying out all co-ordination & liaison work as may be required with electrical inspector, Factory inspector & other statutory bodies for implementation of the work. The application on behalf of the owner for submission to the electrical inspector & other statutory bodies along with the copies of drawings complete in all respects shall be done by the contractor & approval/certificates taken well ahead of time so that the actual commissioning of equipment is not delayed for want of inspection and approval by the inspector & statutory bodies. The Contractor shall arrange the actual inspection work by the electrical inspector.

4.00.00 DESIGN CRITERIA

4.01.00 The basic system connection is shown in drawing no.: 18A03-DWG-E-0002 (Key Single Line Diagram For Station Connection).

4.02.00 All the equipment, material etc. to be supplied shall be new and of the best quality and shall conform to the specification given here under.

All similar materials and removable parts shall be uniform and interchangeable with one another.

4.03.00 The switchgear shall be of compact and modular design, fully metal-clad and of the sulphur-hexafluoride (SF6) insulated type. It shall be constructed for the indicated busbar system and shall include all necessary switches and current and voltage transformers. The switchgear shall be supplied complete with all auxiliary equipment necessary for operation, routine maintenance, repairs or extensions.

Roads and Rail roads for Switchyard shall be provided as indicated in the Plot Plan Drawing 18A03-DWG-M-002A.

GIS building shall be provided with pressurized ventilation in such a way that there will not be dust ingress inside the building. HVAC shall be commissioned before the GIS equipment erection.

Bay connection with proposed GIS bus shall be provided exactly in line with the single line diagram. Also, bidder to note that physical location of GIS bus bar shall be oriented in the same way as shown in the single line diagram. Criss-cross of bus bar of GIS is not allowed.

Bidder to ensure that GIS bus connection with individual bays shall be made with minimum bends and crossing for ease of operation and maintenance, shall be subject to owner's approval during detailed engineering stage.

4.04.00 The switchgear shall be designed for continuous operation under all system Operating conditions including sudden change of load and voltage and short circuits within its ratings.

4.05.00 Components that may require to be renewed and standard assemblies that may be transferred from one circuit to another, shall be interchangeable and where required this shall be demonstrated by the bidder/contractor.

4.06.00 The arrangement of the switchgear shall be in such to enable dismantling a bay without affecting the adjacent bay. However, to remove the busbar disconnector, a shutdown of the relevant section of the busbar will be required.

4.07.00 To secure minimum time of repair, all driving mechanisms of circuit breakers, disconnectors & earth switches shall be respectively interchangeable to those of similar other feeders and/or spare parts shall comprise complete units.

Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to 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 IEC: 62271-102.

4.08.00 The switchgear shall be constructed of suitable material and thickness to withstand the mechanical and thermal stresses due to short circuits and internal arc faults. For the rated duration of short circuit reference shall be made to the design fundamentals and latest IEC recommendations.

4.09.00 Not withstanding scope of supply mentioned above, if any equipment, tools or instrument seems essential for completion, the same shall also be supplied.

4.10.00 The enclosure and seals shall be designed to withstand the gas pressure encountered under normal and short circuit conditions. The thickness of the enclosures shall be in compliance with IEC – 60517.

4.11.00 Viewing windows shall be provided at the disconnectors and earthing switches to ensure that each contact position can be inspected. 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.

4.12.00 Materials used in the manufacture of the switchgear equipment shall be of the type, composition and physical properties best suited to their particular purposes and in accordance with the latest engineering practices. 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.

4.13.00 Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes of the country of origin, or CENELEC standards and based on the design temperature and design pressures as defined in IEC 517.

4.14.00 The initial gas filling of the switchgear and sufficient extra SF6 gas for compensation of possible losses during installation and service for 5 years not less than 10% of the total shall be supplied. A wheeled maintenance device shall be supplied with pressure vessel, vacuum pump and all required gauges and fittings for the service of the switchgear. Bidder shall guarantee that the pressure loss within each individual gas –filled compartment will not be more than 0.5% per year.

4.15.00 Each gas–filled compartment shall be equipped with static filters. These filters shall be capable of absorbing any water vapour, which may penetrate into the enclosures.

4.16.00 The switchgear line-up, when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault condition. Even repeated operations upto the permissible servicing intervals, under full rated fault conditions, shall not lead to diminished performance or significantly shortened useful life of the switchgear. Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. Routine replacement of insulating gas shall not be required in intervals of less than ten years.

4.17.00 Temperature rise of current carrying parts shall be limited to the values stipulated in IEC 62271-1, under rated current and the climatic conditions at site. The temperature rise for accessible enclosure shall not exceed 20°C at an ambient air temperature not exceeding 50°C. In the case of enclosures, which are accessible but need not be touched during normal operation, the temperature rise limit may be permitted up to 30°C.

4.18.00 Bracing shall be provided for all mechanical components against the effects of short circuit currents specified under system parameter. The design of the equipment shall be such that the agreed permitted movements of foundations or thermal effects do not impair the assigned performance of the equipment.

4.19.00 Thermal rating for all current carrying parts shall be a minimum of 1sec. at rated voltage for the rated symmetrical short-circuit current. If the max. short circuit time is extended; the I^2t value shall remain constant.

4.20.00 415V ± 10%, 3-phase / 240V, 1-phase, 50Hz, A.C. and 220V (+10%, -15%) D.C. auxiliary voltage supply for control, alarm, operating mechanism and space heaters shall be provided by the contractor. The bidder may indicate any other auxiliary voltage requirement in the bid.

4.21.00 The switchgear shall be of the free-standing, self-supporting dead-front design, with all high-voltage equipment installed inside gas-insulated, metallic earthed enclosures and suitably sub-divided into individual arc and gas-proof compartments, atleast for:-

- Busbar section with associated busbar disconnector
- Circuit breaker
- Line disconnectors

The busbars shall be sub-divided into compartments including the associated busbar disconnectors.

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

4.23.00 Each line up of switchgear shall be suitable and prepared for future extension on either end 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.

4.24.00 For routine inspections and possible repairs, all elements shall be accessible without removing support structures. The removal of individual enclosure parts or entire breaker bays, shall be possible without disturbing the enclosure of neighboring bays.

4.25.00 It shall be impossible to touch live parts of the switchgear unwillingly, i.e. without the use of tools or brute force or to perform operations that lead to arcing faults.

4.26.00 The primary design goal shall be the avoidance of all known reasons for internal arcing. Should it occur, nevertheless, the release of pressurized gas into the atmosphere must occur in such a controlled way that personnel standing at the operating position of the switchgear will not be hurt directly in the process. Furthermore, no part of the enclosure, or any loose parts, may fly off the switchgear in such an event, and no holes may burn through the enclosure until the nearest protective relay has tripped. All earthing connections must remain operational during and after an arc fault.

4.27.00 All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they cannot be defeated easily, i.e. the operator must use tools or brute force to over-ride them.

4.28.00 The actual position of disconnector and grounding switches shall be positively displayed by means of reliable optical indicators visible from the operating position.

4.29.00 Counter measures against expansion, vibration and noise.

4.29.01 The GIS equipment shall be furnished with specially designed stainless steel compensators/bellows to preserve the mechanical strength of the equipment at the connection portions to deal with the following problems:-

a) To absorb the expansion and contraction of outer enclosure and conductor due to temperature variations

b) Mismatch in various components of GIS

c) To absorb the vibration of the transformer and switching equipment

d) To absorb the dimensional variations due to uneven settling of foundation

e) To withstand seismic forces as mentioned in climatic condition

4.30.00 The GIS assembly shall consist of separate modular compartments e.g. circuit breaker compartment, busbar compartment filled 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-energizing the adjacent feeders. During fault in CB compartment, no bus bar and feeder is permitted out of service during

maintenance and repair/replacement. 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.

4.31.00 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.

4.32.00 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 (PD test as per IEC 62271-203 Table -6)

~~than the rated voltage.~~ They should 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.

4.33.00 Gas barrier insulators (communication type) shall have the same basis of design and shall have holes on both sides for proper flow of gas.

4.34.00 Gas barrier insulators (non–communicable type) shall be provided so as to divide the GIS into separate compartments. They 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. Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced, it should be ensured by the bidder that adjacent compartment would remain in service with reduced pressure. The gas tight barriers shall be clearly marked on the outside of the enclosures.

4.35.00 The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300ms 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. The material of the enclosure shall be of having high resistance to corrosion, low electrical losses and no magnetic losses. The enclosure shall be sized for carrying induced current equal to the rated current of the bus. The enclosure shall be designed to eliminate the external electromagnetic field to reduce electro dynamic stresses under short circuit conditions. The average intensity of the electromagnetic field shall not be more than 50 micro-tesla. The temperature rise of accessible enclosure shall not exceed 20°C above ambient temperature. In the enclosure which is not being touched during normal operation, the temperature rise limit shall be up to 30°C above ambient temperature.

Corri-05: Arc withstand capability as per Table-104 of IEC 62271-203 is acceptable.

4.36.00 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 shall be provided for disconnectors and earth switches.

4.37.00 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.

4.38.00 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.

4.39.00 The bidder shall guarantee that the pressure loss within each individual gas-filled compartment shall not be more than half percent (0.5%) per year.

4.40.00 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 separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

4.41.00 The switchgear shall be divided into separate gas compartments by the use of gas tight barriers to localize any gas leakage. Gas section volumes shall be designed to minimize the effects of any internal over pressure and shall be consistent with need to allow changes in the switching arrangements for maintenance, repair of extension ensuring the remaining parts can remain energized. Each gas compartment shall be provided with facilities for routine checking of gas moisture content and purity. Gas compartments shall be fitted with permanent connection points for fitting and emptying and gas treatment equipment without moving the switch gear and degassing the compartment. Two stage alarms shall be wired and indicated to the LCC and control room in the event of loss of gas pressure. All SF6 gas filling ports in the GIS shall be equipped with standard non-return fitting. Each gas compartment must provide the following:

- Indicator of actual gas pressure, stage-I pressure alarm, stage II pressure alarm pressure for all gas filled compartments
- Monitoring of pressure & alarm for pressure losses in two adjustable stages
- Access for evacuating and filling via gas service cart

4.42.00 The switchgear line-up 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 reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

4.43.00 The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short circuit current.

4.44.00 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, suitably sub-divided into individual arc and gas-proof compartments preferably for:

- Bus Bars
- Intermediate Compartment
- Circuit Breakers
- Line Disconnectors
- Voltage Transformers

4.45.00 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 the one and half breaker bus scheme GIS shall be such that in case one circuit breaker module is removed for maintenance, there is no disruption in the power flow in any of the two circuits. Further the design of double bus with one and half breaker & double bus with double breaker scheme 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 number of intermediate compartments, if required, shall be provided to ensure equipment and operating personnel's safety.

4.46.00 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.

4.47.00 Circuit identifying labels shall be fitted in front and rear of each individual circuits assembly and on control cubicles.

4.48.00 GIS HALL LAYOUT CRITERIA

a. Minimum clearance of 1 meter to be provided over the GIB with the crane hook, sling and lifted equipment hanging over the GIB.

b. Clear space of 5 meters shall be provided on three sides of the GIS (765 kV, 400kV) equipment for easy movement along with equipment / trolley.

c. Clearance on maintenance bay side shall be at least 10 meter wide (clear space from edge of GIS (765 kV, 400kV) to inner edge of wall).

Building width shall be decided considering the requirement of turning radius to rotate the largest removable component for assembly/disassembly.

4.49.00 GIS HALL FLOORING

Epoxy Flooring : Supply & application of heavy duty Self leveling Epoxy Flooring system to an average thickness 2.2 mm, including Surface Preparation, application of one coat of Epoxy Primer, followed by topping the surface with Heavy duty Chemical resistant Epoxy Resin Topping in desired colour and Gloss. Laying and installations of flooring shall be as per IS: 4631-1986. For detailed specification Volume II G1&G2 Civil Sections shall be referred.

5.00.00 SPECIFIC REQUIREMENT

5.01.00 **GIS Equipment and Accessories:**

5.01.01 **Circuit Breakers**

1) 1) Each circuit breaker shall comprise three metal clad breaker poles (puffertype). They shall be designed for installation in SF6 gas-insulated metalclad switchgear and shall use SF6 gas for insulation.33kV GIS circuit breaker shall be SF6 insulated circuit breaker / Vacuum circuit breaker.

2) The circuit breakers shall be horizontal mounted or vertical mounted and shall withstand the forces imposed by the earthquake

3) Breaker shall be suitable for following switching duties:

   a) Terminal faults
   b) Short line faults
   c) Out of phase switching
   d) Interruption of small inductive current including transformer magnetizing inrush currents.
   e) Interruption of line charging currents.

4) The breaker switching under above switching operations shall not result in excessive over voltages and/or restrike of arc.

5) Breaker components shall meet partial discharge requirement as per relevant IEC.

6) The circuit breakers shall be designed to withstand the high stresses imposed on them during fault clearing, load rejection, out-of-phase

switching, re-energization of lines with trapped charge and perform make and break operations as per the stipulated duty cycles satisfactorily.

7) Spring/Hydraulic Operating Mechanism, one for each pole, shall be employed for closing and tripping the circuit breakers. 220V DC will be used for control / tripping.

8) The circuit breakers shall have local storage sufficient for a duty cycle of O-0.3sec-CO following the loss of supply to the main energy storage system.

9) The circuit breakers shall be trip-free and have anti-pumping and phase disagreement protection. There shall be two trip coils per pole of the breakers.

10) Line circuit breakers shall have single-phase auto-reclosing capabilities. The line breakers shall be capable of independent pole operation. Each phase shall be completely isolated from the other two phases.

11) The circuit breaker shall meet all the double circuit transmission line characteristics for any type of fault or fault location and also for line charging and dropping when used on an effectively grounded system. Effect of second circuit in parallel shall also be considered.

12) Each circuit breaker pole shall be equipped with a local enclosed-type mechanical position indicator clearly visible from the breaker front, together with remote position indicator on the bay module control cabinet and remotely at the power house / substation control room. The mechanical indicator wording and colouring shall be as follows:

	Sign	**Background Colour**
Open position	Open	Green
Closed position	Closed	Red

13) The circuit breakers shall be interlocked electrically with their associated disconnectors such that the disconnector cannot be opened or closed unless the associated circuit breakers are open. The interlocking shall prevent any incorrect switching sequence and enable the breakers to be operated without risk, either from the local bay module control cabinet or from the power house / substation control room. Actuation of the manual operating device shall also disable the electrical control circuits. Interlocks shall be provided to prevent hunting and other dangerous or undesirable operations of the circuit breaker.

14) The circuit breaker control system shall inhibit tripping or closing of the circuit breaker when there is insufficient stored energy in the operating mechanism storage cylinder or if SF6 density drops below a minimum permissible level. The state of the breaker arc-quenching & insulating gas shall be monitored by a temperature-compensated density switch with two alarm levels. First stage alarm shall be set well before any

dangerous condition is reached; the second stage shall inhibit breaker operation.

15) The circuit breakers shall be capable of being operated locally or from remote. Local operation shall be by means of an open/close control switch located in the bay module control cabinet. Remote control via a remote / local control transfer switch shall be from the power house / Substation control room. Protection trips shall remain operable in either remote or local control mode. When in the maintenance mode, all remote trip or close control signals shall be blocked. The breaker controls shall operate from the 220V DC system with both the trip coils connected. A manually operated tripping device shall also be provided with each breaker, which can be operated in an emergency or during maintenance. Mechanical indicators coupled to the moving contact system shall be provided to show the true position of the main breaker contacts. Operating counters shall be provided for each breaker pole or otherwise for each breaker.

16) The governing data for the selection of circuit breakers are not only those listed above but also those that can be readily calculated from these documents. The selected circuit breakers must be suitable for their intended service and location for all no load, full load and fault service conditions.

17) Not used.

18) **Operational Requirement**

a) Rated operating duty cycle O-0.3SEC–CO-3MIN-CO

b) Suitable for Single and three phase high speed auto re-closing

c) Trip and closing coil voltage - 220V DC

d) Auxiliary contacts - as required plus 5NO and 5NC contacts per pole / 10NO and 10NC per CB as spare

e) Noise level - as per IEC 61672

f) Controls

1. Closing Circuits - Circuits shall operate correctly at all values of supply voltage between 85% and 110% of rated voltage.

2. Trip Circuits - Two independent tripping circuits, valves, pressure switches and coils shall be provided for connection to different set of relays. The circuits shall operate correctly under all operating conditions up to rated breaking capacity and at all values of supply voltages between 70% - 100% of rated supply voltage. However, even at 50% of rated supply voltage the breaker shall be able to operate. Trip coil supervision shall be provided in both open and close position.

3. Operation - Shall have both local and remote operation of breaker with local / remote lockable selector switch and close and trip control switch / push buttons shall be provided in the breaker control cabinet.

4. Pressure Switch Contacts - Shall have density meter and pressure switch contacts suitable for direct use as permissive in closing and tripping circuits. Separate contacts to be used for each of tripping and closing circuits. Fail safe logic / schemes to be employed if multiplying relays used.

5. Supply Voltage Monitoring - DC supply voltage for all auxiliary circuits to be monitored. Provision shall be made for remote annunciations and operation lockout in case of supply failure.
6. Out of Phase Closing - One closing operation under phase opposition with twice rated voltage across terminals.

7. Safety Aspect - Breaker position shall be maintained on loss of operating media and/or quenching media pressure.

8. Central Control Cabinet - A central control cabinet shall be provided which shall house all the control equipment required for operation, indication, lockout and all requirements as per detailed list given below:

   - Local / remote changeover switch
   - Operation counters
   - Pneumatic / hydraulic pressure gauges
   - SF6 pressure gauges
   - Power supply control switches
   - Fuses
   - Anti-pumping relay
   - Pole discrepancy relay
   - AC/DC supervision relays

g) The circuit breaker shall also be capable of

1. Interrupting line charging current as per IEC 62271-100 without any restrike and without use of opening resistors.

2. Clearing short line fault current with source impedance behind the bus equivalent to symmetrical fault current specified.

19) Design and Constructional Features:

a) Interrupter - shall be with adsorbing product box to minimize the effect of SF6 decomposing product and moisture.

b) SF6 Density - SF6 density shall be monitored and regulated on each pole using individual pressure switches and pressure gauges.

Density Monitor shall be adequately temperature compensated.

It shall be possible to dismantle the monitor without draining SF6 gas & also to remove SF6 gas from each pole separately for maintenance purpose.

c) D.C. Supply - Dual DC supply shall be provided for connection to independent trip circuits, monitoring & control circuits.

d) Auxiliary Switch - Auxiliary switch of breaker to be positively driven by operating rod.

20) Operating Mechanism:

a) Type electro-hydraulic / spring charged or combination of the both with anti-pumping and trip free features.

b) Housing operating box / cabinet shall be accessible to man standing on ground and shall be hot dip galvanized

c) Operation – a mechanical indicator to show open / close position of breaker shall indicator be provided which should be visible with housing closed.

d) Power supply - dual ac power supply with changeover facility.

21) Spring Operated Mechanism

a) Shall be complete with motor, opening and closing spring with limit switch for automatic charging and shall generally meet all the design and operation requirements for satisfactory and trouble free operation.

b) Motor shall be rated to fully charge the closing springs in less than 30seconds and shall have adequate thermal rating for repeated sequence of closing and opening operations of breaker.

c) Closing action of mechanism shall compress / charge the opening spring so that it is ready for tripping. Closing springs shall be immediately charged after the closing operation. After failure of power supply, at least one CO operation should be possible. Breaker operation shall be prevented when spring is in partial charged condition. Indication of spring in charged condition shall be provided in local and remote cabinet.

22) Hydraulically Operated Mechanism

a) Shall comprise of power cylinder, control valves, high & low pressure reservoir, motor, etc. Hydraulic oil used shall be fully compatible for the specified temperature range. Further it shall generally meet all the design and operation requirements for satisfactory and trouble free operation.
b) On failure of power supply and pressure equal to the lowest pressure of auto reclose duty; at least two CO operations should be possible. Also complete duty cycle of breaker to be possible meeting all parameters of break / opening time when oil is at lowest permissible pressure before make up.

c) Provision to be made to continuously monitor oil / nitrogen pressure both local and remote.

d) One hand operated pump shall be provided per station for emergency operation.

23) .The breaker shall also withstand all dielectric stresses in open position at SF6 lockout pressure for **15**minutes.

24) Multi-break interrupters shall have uniform voltage distribution across them.

25) Breakers shall have provision for attaching operational analyzer.

26) Contractor shall supply spare SF6 gas equal to 20% of the total requirement for the station.

27) Controlled Switching Requirements

a) The circuit breaker shall be equipped with controlled switching with consequent optimization of switching behavior when used in switching of 765KV & 400kV transformers (ST, ICT), bus and line reactors. The controller shall be provided in main & tie circuit breakers of transformers & bus reactors.

b) The controlling relay 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.

c) Technical requirement for controlled switching device:

- The controller shall be designed to operate at the correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency.

- The controller shall meet the requirements of IEC- 60255-4 Appendix 'E' class III regarding HF disturbance test and fast transient test shall be as per IEC-61000 – 4 level III and insulation test as per 60255 – 5.

- The controller shall have functions for switching ON & OFF the circuit breakers.

- The controller 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.

- The controller shall also 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, hydraulic/pneumatic pressure of the operating mechanism, control voltage variation, SF6 gas density variations etc. schematic drawing for this purpose shall be provided by the bidder. The accuracy of the operating time estimation by the controller shall be better than + 0.5ms.

- The controller should have display facility at the front for the settings and measured values.

- The controller should 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 bidder to be used on the owner's PC.

- The controller shall have self-monitoring facility. The controller shall be suitable for current input of 1amp from the secondary of the CTs and 110V (Ph to Ph) from the CVTs. The controller shall also take care of transient and dynamic state values of the current from the secondary of the CTs and CVTs.

- The controller shall have time setting resolution of 0.1ms or better.

- The controller 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.

5.01.02 **Current Transformers**

1) The current transformers, incorporated into the GIS, shall be used for protective relaying and metering and shall be ring type, fitted externally to

the supporting enclosure. The CTs shall have multicores with multi-ratio, which shall be changeable by means of taps on the secondary side. The secondary leads shall be brought out into the secondary terminal box. All current transformers shall have effective electromagnetic shields to protect against high frequency transients.

2) CT shall have a short time primary current rating not less than that of the associated switchgear. Secondary windings of each CT shall be earthed at one point only. The thermal rating of the current transformer shall allow, at site conditions, a 20% continuous overloading referred to nominal rating of the current transformer.

3) All transformers are to be provided with an identifying label giving manufacturer, type, ratio, class, output and serial number.

4) Where multiple ratio secondary windings are executed, the above mentioned label shall clearly indicate the terminal connection required for each ratio, and they must be clearly indicated on the appropriate diagrams and drawings.

5) The minimum rated output of CT's shall be 20VA or otherwise approved, based on the stability calculations to be submitted for approval by the bidder. The magnetizing curves for each CT protection cores shall also be submitted for approval.

6) To guarantee the correct protection relay operation, through-fault stability calculations shall be submitted showing the correctness of the chosen CT core, i.e. rated output, class of accuracy, rated accuracy limit factors, the rated primary current, turns ratio, knee-point e.m.f. and resistance of the secondary windings (corrected to the maximum service temperature).

7) A current transformer marshalling terminal box for all the three-phase current transformers shall be provided, outside the enclosure for connections of all cores. The marshalling box shall be used for the star/delta configuration. Sufficient terminals shall be provided.

8) Suitable provision shall be made for primary current injection testing of current transformer circuits.

5.01.03 **Voltage Transformers**

1) SF6 insulated voltage transformers shall be of the inductive type, constructed and tested in accordance with IEC-60044-2. They shall be fully encapsulated. The gas compartment shall be segregated from the adjacent compartments. Minimum rated output shall be 50VA, if not specified or approved otherwise.

2) The thermal rating of the voltage transformer shall allow, at site conditions, a 20% continuous overloading and 50% overloading for 30 seconds with reference to the nominal rating of the voltage transformer.

3) The busbar VT's shall be connected through hand-operated isolators, which are to be provided with padlock facilities & padlocks.

4) Furthermore, to allow the testing of cables without the removal of a V.T., disconnection facilities shall be provided.

5) ~~Secondary fuses shall be of the HRC type,~~ suitably covered and complying with IEC-60269 or secondary circuits shall be suitably supervised by MCCB's of adequate characteristics.

6) The V.T. gas compartment shall be isolated from the adjacent gas compartments with separate gas supervision. If the V.T gas compartment is connected to the line isolator gas compartment a non-return valve shall be provided to avoid entering of any decomposed gas from the isolator gas compartment to the V.T gas compartment.

7) The bus voltage transformers shall be located in a separate bay module on the bus, and shall be connected phase-to-ground to the phase buses and shall be used for protection, metering and synchronizing.

8) Provision for short circuit and overload protection for voltage transformers against external short circuit shall be made. The same shall be installed in a separate marshalling box or control cabinet.

5.01.04 **Disconnecting Switches**

1) The disconnecting switches shall be of the 3-phase, single-pole, group-operated type, installed in the switchgear, in locations as shown on the single-line diagram, to provide electrical isolation of the circuit breakers from the transformer, reactor, double bus and transmission lines. The disconnectors shall be electric motor operated and shall be equipped with a manual operating mechanism for emergency use.

2) The disconnecting switches shall have breaking capabilities as per IEC requirements. Contact shielding shall be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when currents are interrupted.

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

4) Opening and closing of the disconnectors shall be either by local or remote control. Local operation shall be by means of a two-position control switch located in the bay module control cabinet.

5) Remote control through the Remote/Local transfer switch shall be from the switchyard control room.

6) The disconnector operation shall be interlocked electrically with the associated circuit breakers such that the disconnector control is inoperative if the circuit breaker is closed. Actuation of the emergency manual operating device shall also disable the electrical control. Disconnectors in open condition shall be secured against reclosure.

7) Each disconnector switch shall be supplied with 8 NO and 8 NC auxiliary switches for use by others, over and above those required for switchgear interlocking purposes.

8) Signaling of the disconnector closed position shall not take place unless it is certain that the movable contacts has reached a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.

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

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

11) Auxiliary switches shall be capable of breaking at least 0.2A in a 220V DC circuit, with a time constant of not less than 20milliseconds. Final value of breaking capacity of auxiliary switches shall be finalised in consultation with the control and protection bidder. Auxiliary switches shall be positively driven in both directions.

12) Disconnecting switches and adjacent safety grounding switches shall have electrical interlocks to prevent closure of the grounding switches when the disconnecting switches are in the closed position and to prevent closure of the disconnecting switch when the grounding switch is in the closed position. The disconnector shall be pad lockable in the close & open position.

13) Disconnecting switches having adjacent high-speed fault making grounding switches shall be interlocked such that the fault making switches close first to discharge the line charging currents before the respective disconnectors may be opened.

14) When the lines are taken out of service for maintenance, etc., the disconnectors and high-speed grounding switches located on the transmission line feeder modules of the GIS switchgear are required to operate as follows:

    i) After tripping of circuit breaker, operation of the respective disconnector control switch to open will first initiate rapid closure of the associated high-speed grounding switch. When this grounding switch is signaled 'closed' by its auxiliary switches, an adjustable time delay relay will start to allow time for any trapped charges to dissipate into

the grounding network. After the set time delay, the disconnector motor operating mechanism will be energized to open the disconnector.

ii) Operation of the disconnector control switch to close will close the disconnector, which-when proved 'closed', will signal the high-speed ground switch 'to open'.

15) Local control of the disconnectors and high-speed grounding switches from the bay module control panel shall be from individual control switches with the remote/local transfer switch set 'to Local'.

16) All electrical sequence interlocks shall apply in both remote and local control modes but in local mode the time delay relay shall be blocked.

17) Each disconnector switch shall have a clearly identifiable local, positively driven mechanical position indicator, together with remote position indicator on the bay module control cabinet and remotely in the powerhouse/switchyard control room. The indicator shall have the following wording and colouring:

	Sign	**Colour**
Open position	Open	Green
Closed position	Closed	Red

18) Each disconnector shall be fitted with an optical indicator per pole located between the pole and the driving rod so that the open or closed contacts of the disconnector are visible from the floor level.

19) Disconnector intended for use with a circuit-breaker of equal class (extended mechanical endurance) endurance class - M2 as per IEC-62271-102.

5.01.05 **Maintenance Earthing Switches**

1) Three-pole, group-operated, work-in-progress maintenance earthing switches shall be provided as shown on the single-line diagram. Each earthing switch group shall be electric motor (DC) operated. Means of emergency manual operation shall also be provided.

2) In order to provide test facilities, certain earthing switches may require to be insulated from the enclosures and have easily removable ground connections.

3) Each maintenance-earthing switch shall be electrically interlocked with its associated disconnecting switch and circuit breaker such that it can only be closed if both the circuit breaker and disconnecting switch are open. Once closed it shall be secured against reopening.

4) Maintenance earthing switch shall be operable locally from the bay module control cabinet only; remote control is not required.

5) Positive mechanical position indication through reliable optical indicator shall be provided locally at each switch and remotely at each bay module control cabinet and in the powerhouse control room. The indicator shall have the following wording and coloring:

	Sign	Background Colour
Open position	Open	Green
Closed position	Closed	Red

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

7) Each earthing switch shall be fitted with 4 NO and 4 NC auxiliary switches for use by others, over and above those required for local interlocking and position indication purposes.

8) Provision shall be made for padlocking the earthing switches in either the open or closed positions.

9) All portions of the earthing switch and operating mechanism requiring grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 50mm^2.

10) On opening, the line earthing switch should be able to break current induced by parallel lines according to IEC provisions.

11) The maintenance earthing switches shall conform to the requirements of IEC 129.

12) Electrical endurance for earthing switches: Earthing switches with short-circuit making capability class E1 and shall conform to the requirements of IEC 62271-102.

5.01.06 **Fast Acting Earthing Switches**

1) Fast acting earthing switches shall be located at the bus bar and at all external HV connections of feeders like HV cables or overhead lines or transformer connections .The Fast Acting Earthing switches shall have inductive and capacitive current switching capability as per IEC-62271-102.

2) Fast acting earthing switch shall be single pole operated with one motor operated mechanism per single pole position. They shall also have facility for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

3) The switches shall be fitted with a stored energy closing system to provide fault-making capability.

4) The short-circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating.

5) Each switch shall have a positive local mechanical position indicator and a remote indicator at the bay module control cabinet, and in the powerhouse / switchyard control room. The indicator wording and colouring shall be as follows:

	Sign	Background Colour
Open position	Open	Green
Closed position	Closed	Red

6) High-speed ground switch operation shall be done locally from the bay module control cabinet, or remotely from the power house / switchyard control room in conjunction with opening of the associated disconnector switch.

7) These high-speed grounding switches shall be electrically interlocked with their associated circuit breakers such that the grounding switches cannot be closed if the circuit breakers are closed. The grounding switches shall be required to close before the disconnector switches are opened in order to dissipate the trapped charges, when the lines are taken out of service for maintenance, etc.

8) Interlocks shall be provided such that insertion of the manual operating devices will disable the electrical control circuits.

9) Each high-speed grounding switch shall be fitted with 8 NO and 8 NC auxiliary switches for use by others, over and above those required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the grounding switches in either the open or closed position.

10) All portions of the grounding switches and operating mechanism-requiring connection to ground shall be connected together utilizing flexible copper conductor having a minimum cross-sectional area of 50 mm^2.

11) The high-speed make proof grounding switches shall conform to the requirement of IEC 129.

12) Electrical endurance for fast acting earthing switches: Earthing switches with short-circuit making capability class E1 and shall conform to the requirements of IEC 62271-102.

5.01.07 **Surge Arresters**

1) Surge arrester shall be of SF6 gas insulated, metal enclosed, gapless metal oxide, heavy duty, station type.

2) The surge arrester shall successfully drain the dynamic currents repeatedly caused by impulse waves. The ground connection shall be sized for the fault level of the GIS.

3) The arrester tanks shall be vertically or horizontally mounted to best suit bidder's switchgear layout, and shall be fitted with pressure relief vents directed away from areas frequently used by operating personnel. Each arrester unit shall be fitted with a discharge counter located in an easily accessible position.

5.01.08 **GIS Termination Arrangement**

1) Outdoor SF6 bushings, for the connection between the GIS and overhead lines or conventional air insulated equipment shall be furnished where specified.

2) Bushing shall comply with the relevant IEC standards. The bushing can be with composite insulators (silicon rubber) or with porcelain insulators with all surfaces free from imperfection. The internal and external electrical field of the bushings can be controlled by a capacitive grading body or by grading shields.

3) For SF6/Air bushings, the bidder shall provide detailed drawings and information.

4) The design of the cable termination/ end box shall fully comply with the IEC 62271-209 standard. All cable end moulds shall be suitable for connecting single core, XLPE cable.

5) For cable end terminations, the bidder shall submit detailed drawings illustrating clearly the scope of supply boundaries.

5.01.09 **Bus bars and Bus ducts**

1) The SF6 single-phase encapsulated busbars and busducts shall be mounted in horizontal / vertical configuration to suit the switchgear layout and shall be single phase encapsulated.

2) The conductors of the busbars shall be fabricated of aluminum alloy tubular sections of cross sectional area suitable to meet the current rating requirements. The tubular bus sections shall be housed in an aluminum enclosure, filled with pressurized SF6 gas. The conductors shall be supported from the enclosures by homogeneous epoxy resin insulators shaped to ensure uniform electrical field distribution at rated voltage. Adequate provision shall be made for absorption of thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. Metal bellow type compensators with adjustable tensions shall be provided, where required. The enclosures shall be designed to eliminate as much as possible all external effects of the flux created by normal and fault currents. The power losses in the system shall be kept to a minimum, and induced

voltages on the enclosures shall not be allowed to exceed reasonable limits of safety for operating personnel. The bidder shall furnish supporting calculations in respect of induced voltage and losses guaranteed for the enclosure.

3) Bus end connections shall be made with multi-contact connectors to allow for axial thermal expansion of the bus. Enclosure end connections shall be flanged, and shall be fitted with gaskets or O-ring seals to provide an effective gastight joint between sections allow for axial thermal expansion of the bus. Enclosure end connections shall be flanged, and shall be fitted with gaskets or O-ring seals to provide an effective gastight joint between sections.

4) The common point of the two busbars should be in a separate enclosure with an earthing switch in order to ensure availability of one busbar in service at all times.

5) Each end of the busbars shall be designed for convenient future extension of the switchgear. Bus conductor end connectors and enclosure flanges shall be designed accordingly.

6) All necessary steel supporting structures required for proper erection, the bidder shall provide leveling and alignment of the busbars and bus ducts.

7) In order to provide an improved dielectric withstands capacity, the interior of enclosures may not be required to be painted.

5.01.10 **Steel Structures**

1) Bidder shall supply all equipment supporting structures required access ladders / stairway / walkways, transverse and longitudinal beams and supporting members, complete with all necessary hardware. Any temporary scaffolding or a movable platform, required for maintenance, shall also be supplied. In GIS one number walkway to be provided for approach from front to rear of GIS. Only in case a clear passage of 800mm x 1800mm high is provided below the SF6 filled busbars of GIS then additional walkway need not be provided.

2) All steel structure members shall be hot-dip galvanized after fabrication. All field assembly joints shall be bolted. Field welding shall not be acceptable.

3) Non-corrosive metal or plated steel shall be used for bolts and nuts throughout the work. Bidder shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

4) Foundation channels and anchor bolts shall be provided.

5.01.11 **Insulating Gas**

1) The SF6 gas required for first filling shall be furnished with the switchgear, along with connecting hose and fittings.

2) Characteristics

   i) SF6 gas to be filled in GIS shall in all respect conform to the following values (in accordance with IEC Publication no. 60376):-

      a. Impurity max allowable concentration (by weight)

      b. Air 0.05% CF4 0.05% Moisture 15 ppm Hydrolysable fluorides expressed as HF 1.0 ppm. During commissioning the dew point of SF6 gas shall be measured and documented.

3) Gas System

   i) The gas pressure shall be based on the design. The gas system shall be independently separated into logical groups to provide the largest practical gas reservoir for least leaks, but small enough to permit optimum installation, maintenance and leak detection procedures.

   ii) The independent gas section shall be separated by gas-tight barriers, capable of withstanding full pressure from either side with a vacuum on the opposite side.

   iii) Gas barriers shall be provided in line with Gas Single Line Diagram (DWG.No. 18A03-DWG-E-0002) as a minimum requirement, and to meet Service continuity requirements..

4) Gas Monitoring Devices

   Temperature-compensated two (2) independent gas density monitoring devices shall be provided for each gas compartment to improve the reliability. The devices shall provide continuous and automatic monitoring of the density of the gas. Hybrid / Mechanical & Electronic type density monitor shall also be provided per gas compartment to improve the reliability. Static filters and Rupturing disk for each compartment shall be provided. The monitoring device shall have two alarm settings. These shall be set so that :-.

   i) Advance warning can be given that the gas density is unacceptably low.

   ii) After an urgent alarm, measures can be taken to immediately isolate the particular compartment electrically by tripping circuit breakers and opening the disconnecting switches.

5.01.12 **SF6 Gas Processing Unit**

1) Two nos SF6 gas processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF6 gas during the initial installation, subsequent maintenance and future extension of GIS, shall be provided. The cart shall be equipped with rubber wheels and shall be easily maneuverable by two workers within the GIS building.

2) The unit shall be self-contained (except for additional gas storage bottles and external power supply at 415V AC, 3-phase, 50Hz) and fully equipped with an electric vacuum pump, gas compressor, gas drier, gas filter, refrigeration unit, evaporator, gas storage tank, full instrumentation for measuring vacuum, compressor inlet temperature, tank pressure and temperature, valves and piping to perform the following operations as a minimum requirement:

   i) Evacuation from a gas filled compartment using the vacuum pump.

   ii) Transfer of SF6 gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter;

   iii) Recirculation of SF6 gas in the storage tank through the drier,

   iv) Recirculation of SF6 gas in any switchgear or bus duct compartment through the drier and filter;

   v) Evaporating and filling SF6 gas,

   vi) Drawing off and liquefying SF6 gas,

   vii) A combination operation of filling SF6 gas into a gas system and evacuating a second, gas system using the vacuum pump.

3) Adequate length of hoses shall be provided for filling of SF6 gas in any of the gas compartment with the help of gas cart.

4) SF6 Gas Leakage Detecting Instruments

   Two numbers portable SF6 gas leakage detecting instruments shall be provided as mentioned in Tools and Tackles. The portable SF6 gas detector shall be light weight and provided with long flexible probe to enable detection of SF6 gas leakage from areas of gas leakage.

5.01.13 **Corona**

In general the contours of energized metal parts of the GIS and any other accessory shall be such as to eliminate areas or points of high electrostatic flux concentrations. Surfaces shall be smooth with no projection or irregularities, which may cause corona.

5.01.14 **Fire Retardant**

1) All components shall be fire retardant and shall be tested in accordance with IEC 695. Gas emissivity when the material is heated shall be minimal. PVC material shall not be used but fire retardant cables as per IEC 332-1 may be used.

2) Control wire in a grouped environment shall not convey flame; continue to burn when tested as per IEC 695. The method of test and criteria for success or failure shall be in accordance with the above IEC.

5.01.15 **High Voltage Transients**

High voltage transients from switching operations and internal faults are coupled to the external sheath of GIS. Since the effects of these transients on people are not known, operation personnel are required to avoid contact with the sheath during switching operations. Such a restriction is considered undesirable, and the bidder may therefore provide devices and techniques, which may reduce such hazard or new techniques to reduce transients to an acceptable safe level.

5.01.16 **Service Life**

SF6 circuit breakers, disconnecting switches and ground switches will be subjected to frequent, and occasionally repetitive, no load operations and switching offload, capacitive and inductive current within their ratings. In order to minimize maintenance and component replacement, the bidder shall submit proof and further guarantee that all offered SF6 GIS equipment has a minimum service life of 10,000 normal operations. The maintenance free period for any of its external components shall not be less than 5 years intervals. Internal components including refilling of gas shall not be less than 10 years. The bidder shall propose the recommended period for schedule maintenance.

The electrical & mechanical duty class of the GIS equipment shall be as follows:

SL NO	ITEM	MECHANICAL DUTY CLASS	ELECTRICAL DUTY CLASS
1	Circuit Breakers	M2	~~E2~~ E1
2	Disconnectors	M2	~~E2~~
3	Fast Acting Earth switches	-	E1
4	Maintenance Earth switches	-	~~E1~~ E0

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5.01.17 **Grounding of GIS**

1) GIS will be housed on GIS floor. The bidder will also provide underground mat below the substation with adequate number of galvanized iron risers.

2) The bidder shall also supply entire material for ground bus of GIS viz. conductor, clamps, joints, operating and safety platforms etc. to be laid / embedded in GIS floors. The bidder Is also required to supply all earthing connectors and associated hardware material for:-

   i) Connecting all GIS equipment, busduct, enclosures, control cabinets, supporting structures etc. to the ground bus of GIS, and

   ii) Connecting ground bus of GIS to the ground mat

3) The grounding arrangement of GIS shall ensure that touch and step voltages are limited to safe values. The enclosures of the GIS shall be grounded at several points such that there shall be a grounded cage around all live parts. The ground continuity between each enclosure shall be affected over flanges, with or without links or straps to bridge the flanges. Copper / aluminum straps shall however bridge the metallic expansion bellows.

4) Where operating mechanism cabinets are mounted on the switchgear, the grounding shall be made by separate conductor. LCCs and marshalling boxes shall be grounded through a separate conductor.

5) All conduits and control cable sheaths shall be connected to the control cabinet or marshalling box grounding bus. All steel structures shall be grounded.

6) Each removable section of catwalk shall be bolted to the support structure for ground continuity.

7) The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS.

8) The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated max. fault current without overheating by at least from two paths to ground from the main ground bus.

9) Provisions of IEC 62271 -203 regarding safeguards in earthing of connected cables, testing during maintenance and other safety measures shall be ensured.

5.02.00 **Local Control Cabinet for GIS**

5.02.01 Indoor mounted, freestanding type local control cabinets for GIS shall be provided, one no for each bay with IP52 degree of protection with neoprene gasket for all doors and openings.

5.02.02 Local control cabinet for GIS shall be provided with min. 300 terminals and two subsections, viz, indicators for bay equipment, terminal box and auxiliary supply distribution box.

5.02.03 Terminal box : providing intermediate termination of all auxiliary contacts of breaker, isolator & earth switch (whether used or not) & preparing interlocking

5.02.04 Auxiliary supply distribution box from where both AC auxiliary supply, heating / lighting supplies and DC auxiliary control supply shall be distributed to various motors of all CBs, isolators, earthing switches and equipment terminal boxes.

5.02.05 All terminals shall be of stud and nut type and mounted on DIN channels.

5.02.06 The local control cabinet shall also be provided with lockable doors, panel illumination lamps with CFL and door switch, 15A power socket with switch, space heater with thermostat switch.

5.02.07 All auxiliary contacts of the CBs, isolators and earthing switches shall be terminated in terminal box section of bay marshalling control cabinets. All hardwired interlocking shall be wired in the above box.

5.02.08 Provision for terminating one number of 3-phase, 4-wire AC, 50Hz power supply shall be provided. Contacts for remote alarm for supply fail shall be provided. Control cable between LCC and GIS equipment unarmoured screen cable of 1.1kV grade multi core, annealed copper conductor, Tinned copper braided screen, prefabricated cable with heavy duty multi point plug in connection on GIS end shall be provided.

5.02.09 Single phase, 240V, AC heating and lighting supply shall be provided in loop in / loop out mode at bay marshalling cabinets. The heating and lighting supply shall be sub-distributed in radial way to provide heating and lighting supplies for all CT / PT marshalling boxes and each bay marshalling control cabinets.

5.02.10 The scheme for all protections, controls, indications, interlocking, metering, AC distribution and all other schemes shall be prepared in such a way that cables shall be laid in radial pattern. Loop formulation of cables shall be completely avoided.

5.03.00 **Control, Metering and Protection**

5.03.01 Comprehensive controls, metering, protection, alarm and indication shall be provided for sub-station equipment & system.

5.03.02 Electrical relay panels shall be provided for 765KV, 400KV & 33KV substation and the same shall be located in the substation control room along with bay controllers.

5.03.03 Each bay controller unit will control one circuit and associated disconnecting switches, earth switches and instrument transformers along with bay mimic. The bay controller unit along with numerical relay and protection panel, station HMI shall be housed in air- conditioned substation control room.

5.03.04 The objective of the protective system is to protect the equipment from damage against fault detected in the equipment or in the system. The protection scheme shall be such as to protect the equipment during system disturbance.

5.03.05 Automatic trip function will be initiated for isolation of faults, which could cause immediate and severe damage. This isolation will also help maintaining the continuity of supply.

5.03.06 Every effort shall be made to avoid unnecessary tripping. Wherever possible, there will be annunciation to alert the operator for taking corrective measure in time.

5.03.07 At least two protective devices operating in parallel on different principles shall be utilized in protection of 765KV & 400KV lines.

5.03.08 The bidder shall furnish with their offer a Single Line Diagram for Metering and Protection scheme of the Substations and a write-up on the Operation & Control Philosophy of the system.

5.04.00 **Miscellaneous Substation Equipment & Accessories**

5.04.01 The scope of supply and installation includes also the following equipment with all accessories, which shall comply with the specification as detailed in relevant sections/clauses.

a) 415V PMCC, AC & DC distribution
b) 220V DC Battery and Battery Charger, DCDB
c) 48V DC Battery and Battery Charger, DCDB for PLCC
d) Switchyard Relay Panel
e) Substation Automation System
f) LT Power and Control Cable
g) Illumination System
h) Lightning Arresters
i) Current Transformers for Tariff Metering
j) Capacitive Voltage Transformers for Tariff Metering
k) Power Line Carrier Communication Equipment & Wave Trap
l) Outdoor Switchyard Materials and Hardware

5.05.00 **Grounding for AIS**

5.05.01 An underground grounding mat to be provided at a depth of 600mm (minimum) within the substations to provide low impedance discharge path to

earth for lightning surge, switching surge and fault energy of the system. The risers at different location at a height of 300mm from the finished floor level (FFL) shall be provided for equipment connection. The earth resistance shall be brought down to less than 1ohm-m

5.05.02 The given values are tentative. Actual values to be decided after analyzing the soil resistivity and subjected to owner's approval.

5.05.03 The minimum ground conductor sizes to be used for underground grounding mat shall be as follows:-

Main ground conductor for grounding mat underground	40mm diameter mild steel
Ground electrode	3m length 40mm diameter mild steel
Risers for equipment connection	40mm diameter mild steel

5.05.04 The bidder shall connect all equipment and structures by using grounding conductor as indicated below:

Over-ground grounding grid and equipment connection	75 x 10 mm GI flat
Control & relay panels / distribution boards etc.	40 x 6 mm GI flat

5.05.05 Testing arrangements shall be provided at suitable locations.

5.05.06 The bidder shall consider in his scope separate electronic earthing pit / grounding arrangement for numerical relays and substation automation system (SAS).

5.05.07 Soil excavation and backfilling for ground grid shall be in the scope of bidder.

5.06.00 **Shielding for AIS**

5.06.01 Shielding wires of 7/8 galvanised steel wire (11 Kg/sq.mm. quality) will be strung between gantry supports / power house wall, over the phase conductors. For 765KV & 400KV lines shielding wires will be strung between outgoing gantry and dead end towers. The complete shielding network will be connected to the main ground mat of the switchyard.

5.06.02 The lightning protection system shall be designed based on IEC: 62305.

5.06.03 The down conductors shall be 75 x 10mm G.I. flat minimum.

5.06.04 Electrodes shall be provided at each connection point of down conductor and underground ground mat.

5.07.00 **D.C. Supplies**

5.07.01 Two sources of 220 V DC supplies shall be provided for essential functions such as protection, circuit breakers closing/tripping, alarms, control, emergency lighting, communication equipment etc.

5.07.02 48V DC supply system shall be provided for PLCC System.

5.07.03 Battery and battery charger shall have SAS connectivity facility.

5.07.04 The battery system shall comply with the specification laid down in section III.

5.08.00 **Switchyard Relay Panel**

This specification covers the design, manufacture, assembly, testing at manufacturer's works, supply & delivery of switchyard relay panel complete with all materials and accessories for efficient and trouble-free operation.

5.08.01 Electrical relay boards as listed below, in accordance with this specification:

Corri-05: Switchyard Control room mentioned in this clause refers to GIS Relay Panel

SR NO	RELAY PANEL	TYPE	QUANTITY (IN SET)	LOCATION
1.	765KV & 400KV Line Bay Relay Panel	Simplex Vertical	765KV Line :Four (4) sets, 400KV Line : Three(3)sets One (1) for each Line Bay	SWYD Control Room
2.	765KV GT Bay Relay Panel	Simplex Vertical	Three (3) sets, One (1) for each GT Bay	SWYD Control Room
3.	400KV ST Bay Relay Panel	Simplex Vertical	Three (3) sets, One (1) for each ST Bay	SWYD Control Room
4.	765KV & 400KV Bus/Line Reactor Bay Relay Panel	Simplex Vertical	765kV & 400kV Bus/Line Reactor Bay Relay Panel - Five (5) sets, One(1) for each Bus/Line	
5.	765KV & 400KV Busbar Protection Relay Panel	Simplex Vertical	One (1) set for each voltage class for complete Bus Bar Protection	SWYD Control Room
6.	Relay Panels for Tie Breakers	Simplex Vertical	765KV : Six (6) sets, 400KV : Six (6)sets One (1) for each Tie Bay	SWYD Control Room
7.	Relay Panels for 33KV Outgoing Feeder	Simplex Vertical	One (1) for each outgoing feeder	SWYD Control Room
8.	Relay Panels for ICT	Simplex Vertical	765KV ICT : Two (2) sets, 400KV ICT : Two (2) sets 400KV IBT : Two (2) sets 33KV IBT : Two (2) sets	SWYD Control Room

Each Set of Relay Panel contains a no. of Relay Panels side by side. e.g. one set of Line Bay, GT Bay & ST Bay Relay Panel may contain 2 nos. of Vertical Panels each, one set of Tie CB & BR Bay Relay Panel may contain 1 no. of Vertical Panels each and one set of Bus Bar Protection Relay Panel may contain 2-3 nos. of Vertical Panels.

5.08.02 The relay board shall accommodate all switches, relays and auxiliary relays for control, monitoring and protection of respective circuit.

5.08.03 Furnishing, mounting and wiring of all equipment, devices and accessories.

5.08.04 All relay panels for 765KV, 400KV & 33KV GIS substation shall be installed in SWYD control room.

5.08.05 Floor channel sills, vibration damping pads and kick plates for the panels complete with holding-down bolts and nuts.

5.08.06 Generator Transformer (GT), Station Transformer (ST), Inter-Connecting Transformer, Inter-Bus Transformer, Bus Reactor (BR), 765KV & 400KV Line Feeders and 33KV Outgoing Feeders of the 765KV/400KV/33KV substation shall be controlled through associated Circuit Breakers and Isolators from SWYD Control Room through software based dedicated Substation Automation System (SAS). Apart from controlling of equipment, this SAS system shall also perform measurement, indication, monitoring and annunciation functions. This SAS system shall be hooked up with station DDCMIS.

5.08.07 Further, the 765KV generator transformer breakers shall also to be controlled from Generator Auxiliary Control Console, located at power plant control room.

5.08.08 The GIS will be provided with one-and-half breaker scheme for 765kV & 400kV. For 33 kV Metal Clad GIS Switchgear shall be provided with Two incomers, One incomer connected to each bus section and a Buscpupler between the bus sections.

5.08.09 Each 765KV, 400KV & 33KV feeders shall have facility for live bus and dead bus closing. Live bus closing shall be ensured through synchro check relay, to be provided separately in each bay protection panel.

5.08.10 The relay panels will be used for protection of the electrical systems. The panels shall be complete with all necessary hardware to implement the protection, synchronizing and interlocking scheme required for safe and trouble free operation of 765KV/400KV/33KV substations equipment.

5.08.11 All equipment and accessories required for visual indication and audible alarm shall also be accommodated in respective panels.

5.08.12 Construction

1. The relay boards shall be totally enclosed, floor mounted, free-standing, dead-front assemblies conforming to IP-52 degree of protection.

2. Design, material selection and workmanship shall be such as to present a neat appearance outside and inside with no welds, rivets, screws or bolt heads apparent from the exterior surface of the boards. The boards shall have a smooth and uniform matt finish, free from scratches, dents, and other imperfections.

3. The panels shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.

4. Each board may consist of a number of panels mounted side-by-side, in which case, these shall be bolted together to form a compact unit. Wherever, two panels meet, the joints shall be smooth, close-fitting and unobtrusive.

5. The relay boards shall be of folded sheet steel construction, assembled on channel/angle base plates with anti-vibration mountings.

6. The boards shall be fabricated of minimum 2mm thick sheet steel, free from all surface defects. The boards shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration and to provide rigidity during shipment and installation.

7. All doors and removable covers shall be provided with neoprene gaskets all around and latches sufficiently strong to hold them in alignment when closed. The door-operating handle shall have locking arrangement.

8. The boards shall be complete with vibration damping pads, stainless steel kick plates, floor channel sills, anchor bolts, and other necessary hardware for mounting.

5.08.13 Equipment Mounting

1. All relays, instruments, meters, switches etc. mounted on the front face of the panels shall be of flush or semi-flush type.

2. All equipment shall be so mounted that the removal and replacement may be accomplished individually without interruption of services to others.

3. All equipment inside the panels shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

4. The centre line of switches, push buttons and indicating lamps shall not be less than 750mm from the bottom of the panel. The centre line of relays, meters and recorders shall not be less than 450mm from bottom of panel.

5.08.14 Name Plate

1. Nameplates shall be provided on each panel and on each instrument or device mounted in the panel.

2. The material of the nameplates shall be lamicoid or approved equal, 3mm thick, with white letters on black background.

3. The nameplates shall be held by self-tapping screws. The size of nameplate shall be approx. 20mm x 75mm for equipment and 40mm x 150mm for panels.

4. Nameplates for panels shall be provided both on the front and the rear.

5. Control and meter selection switches shall have integral nameplates.

6. Nameplates for all other devices shall be located below the respective devices.

7. Instrument and devices mounted on the face of the control boards shall also be identified on the rear with the instrument or device number. The number may be painted on or adjacent to the instrument or device case.

5.08.15 Illumination, Space Heating and Receptacles

1. Each panel shall be provided with interior lamp with door switch, space heater with thermostat and switch and 15A, 5-pin receptacles with plug. Fifth pin of the socket shall be effectively grounded through the metallic structure.

2. Compact fluorescent lamp, heater and receptacle circuits shall be suitable for available AC supply and furnished with individual ON-OFF switch.

3. The compact fluorescent lamp shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

5.08.16 AC/DC Power Supply

1. Necessary AC and DC supplies to each control boards, circuit breakers, isolators, etc. as required for control and service, shall be provided by the bidder. Single feeder may be arranged for AC supply but duplicate feeders shall be arranged for DC supply. These switches shall be mounted inside the panel. auto change over facility shall be provided for DC supply from source to service

2. Alarm relays with reverse flag shall be provided to annunciate failure of main incoming AC and DC supplies and annunciation DC supply in each panel. Lamp indications shall be provided individually for Main DC Supply-1 Fail, Main DC Supply-2 Fail and Panel Annunciation DC Supply Fail. A common AC electric bell shall be provided to give an audible alarm in case of failure of DC Supply-1 / DC Supply-2 / Annunciation DC Supply in any

panel. A common push-button shall also be provided for cancellation of lamp indication and audible alarm.

3. Isolating switch fuse units/MCB shall be provided for the incoming DC/AC power supplies. Power supply isolation switches shall be 4-pole, single throw, for AC (considering single feeder) and 2-pole, double throw with OFF, for DC

4. Fuse and link/MPCB shall be provided for individual circuits for protection and also for isolation from bus bar without disturbing other circuits.

5. The fuse requirements in each panel shall be grouped in easily accessible fuse blocks. The groupings shall be done in a neat and orderly fashion.

5.08.17 Wiring

1. The boards shall be fully wired at the factory to ensure proper functioning of control, protection, and metering schemes. When panels are arranged to be located side-by-side, all inter-panel wiring shall be carried out by longitudinal troughs extending the full length of the board.

2. All spare contacts of relays and switches shall be wired upto terminal blocks. All interconnections between the panels of the control board shall be furnished.

3. Wiring shall be done with flexible, heat resistant, 1100V grade, PVC insulated, switchboard wires with stranded copper conductor. The minimum size of the wires shall be 2.5 sqmm. for current & PT circuits and 1.5sqmm. for control circuits.

4. Each wire shall be ferruled by plastic tube with indelible ink print at both ends having terminal block no. & terminal no. as per approved wiring diagram. RYB colour wiring shall be used for CT &PT wiring

5. All wire terminations shall be made with insulated sleeve, solderless type tinned copper lugs. Wire shall not be tapped or spliced between terminals.

6. Wiring shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on the termination.

5.08.18 Terminal Block

1. Terminals shall be box-clamp and clip-on type, suitable for terminating upto two wires of 2.5sqmm. cross section and provided with marking strips. Terminals for CT secondary leads shall have built-in disconnecting links with facility for shorting. Terminals for CT leads should have adequate cross section for terminating associated CT leads.

2. Not more than two wires shall be connected to one terminal. If necessary, a number of terminals shall be jumpered together to provide wiring points.

3. Each terminal shall be identified with designation as per approved schematic.

4. At least 20% of the total number of active terminals shall be furnished as spare in each panel.

5. The wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

6. The terminal blocks shall be located to allow easy access and also to suit floor openings for cable entry.

7. Terminal blocks shall generally be mounted vertically with adequate spacing (not less than 100mm) between adjacent rows.

8. The bottom of the terminal blocks shall be at least 200mm above the incoming cable gland plate.

5.08.19 Cable Entry

1. The panel shall have provisions of cable entry from the bottom. Bottom plate shall be provided to make entry dust-tight.

2. The panels shall have provisions inside for fixing the multi-core cable glands.

3. Cable glands shall be double compression type. Cable gland support plate shall be 4mm thick and mounted not less than 200mm above floor level.

5.08.20 Grounding

1. 25 x 6mm tinned copper ground bus shall be provided on each relay panel extending along the entire length of the assembly.

2. The ground bus shall have two-bolt drilling with GI bolts and nuts at each end for connection to ground grid.

3. The ground bus shall be bolted to the panel structures and effectively ground the entire assembly. The cases of relays, meters and other devices shall be grounded through the steel structure. Doors shall be connected by flexible copper braids for ground connection with fixed part of panel.

4. Whenever a circuit is shown grounded, a single wire from the circuit shall be run independently to the ground bus and connected to it.

5. Potential and current transformer neutrals shall be grounded only at the terminal blocks where they enter the control boards from the transformers

5.08.21 Painting

1. The steel surfaces shall be 7-tank chemically cleaned, rinsed, phosphated and dried.

2. The relay panels shall be finished with electrostatic or powder painting process, white inside and Grade 631 of IS 5 outside. Thickness of paint shall not be less than 20micron.

3. The boards shall have a smooth and uniform matt finish, free from scratches, dents and any other imperfections. Sufficient quantity of touch-up paints shall be furnished for application at site.

4. The bidders are requested to furnish the details of process adopted by them for pre-treatment and painting of sheet metal for the control & relay panels.

5.08.22 Operating Range

Unless otherwise specified, all instruments and relays shall be suitable for operation on 1A CT secondary circuits and/or 110V AC (phase-to-phase) or 63.5V AC (phase-to-neutral) VT secondary circuits. The DC auxiliary voltage shall be 220V.

5.08.23 Relays

1. Relays shall be furnished in rectangular / square dust tight, drawout or rugged plug in type, flash /semi flash mounting cases.

2. The hardware design for protection and associated equipment shall use latest state-of-the-art technology and shall generally be integrated numerical, modular in nature. Where design is based on microprocessor technology adequate self-testing / monitoring / diagnostic facilities shall be provided.

3. The design of the transformer protection and substation protections shall be based on numerical techniques. All the analogue signals will be converted into digital data, using analogue-to-digital conversion circuit. The data will be processed by a microprocessor, which will perform digital signal processing and executes various protection algorithms. Relays shall be provided with two (2) no. Laptop-PC for user interfaces, monitoring, testing facility etc. in switchyard control room. In addition to above, an industrial grade PC based with 21" LCD / plasma colour monitor shall be provided for substations for configuration and diagnostics of all the numerical relays. Such Station shall be complete with licensed version of all softwares.

4. The relay shall be designed to perform satisfactorily under highly noisy electrical environment. Sufficient degree of high frequency disturbance immunity and impulse voltage withstand capacity shall be built into electronic designs as stipulated in relevant standards.

5. Relay characteristics shall be coordinated for proper functioning in conjunction with associated relays. The bidder shall co-ordinate the characteristics of all relays to suit the system and equipment parameters. Relay ranges and settings shall be selected accordingly.

6. The relays shall function satisfactorily being located in non-AC physical environment also.

7. All protections shall be furnished compete with necessary auxiliary, supervisory, lockout relays. Suitably separate sets of single phase auxiliary CT/PT with multiple taps shall be provided with relay whenever required.

8. Visual and audible alarm annunciation shall be initiated in the event of operation of protective/supervisory relay.

9. DC circuits shall be supervised by relays.

10. Tripping shall be done through high-speed lock-out relays.

11. All numerical relays, auxiliary relays shall be of types, proven for the application, satisfying the requirements specified elsewhere and shall be subject to the Owner's approval.

12. The necessary auxiliary relays, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when the relay is de-energized, shall be employed in the circuits.

13. Relays shall be provided with self-reset contacts except for the trip lockout, which shall have contacts with a manual reset feature. Manual resetting shall be possible from Control Level 2 as well as Control Level 1 with suitable authorization.

14. Transients present in CT & VT connections due to extraneous sources in the EHV system shall not cause damage to the numerical and other relays. CT saturation/ transients shall not cause mal-operation of numerical relays.

15. Only DC/DC converters shall be provided in the solid state devices / numerical relays wherever necessary to provide a stable auxiliary supply for relay operation. Except for event logging, alarm and annunciation type of non-trip functions, protective relay contact multiplication shall be done through high speed trip relay only.

16. DC batteries inside protective relays necessary for relay operation shall not be acceptable. Equipment shall be protected against voltage spikes in the auxiliary DC supply.

17. Each numerical relay shall have a USB/serial interface on the front for local communication to a Personal Computer and Printer. Additionally,

facilities shall be provided to access each discrete protection function including modification in relay settings and monitoring of the relay from a HMI. For numerical relays of switchyard, the HMI shall be located in SWYD control room at the Substation Level and for those in GRP, dedicated engineering /DR work station has to be provided in CER. A print out of all settings, scheme logic, event records etc. shall be accessible through the HMI. The display of various measured parameters during normal as well as fault conditions on a segregated phase basis shall be provided. LEDs and a backlit LCD screen shall be provided for visual indication.

5.08.24 Void

5.08.25 Lamps

LED lamp shall be provided for status indication of circuits. The body shall be made of poly carbonate unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200mcd.

5.08.26 Transducer

Transducers shall be of double channel output type (slim model, latest version). The output signal shall be 4-20mA DC corresponding to the measurement range. The output coming out of the transducer shall be capable of driving loop resistance of at least 700 ohms at 24V or proportionately with power supply. Transducer shall be two wire type. All equipment shall be suitable for satisfactory operation at the environment indicated elsewhere in this specification. Transducers shall be mounted on rack inside panel and shall provide easy access. Transducers shall be provided with high accuracy class.

5.08.27 Auxiliary Devices

1. The Contractor shall furnish, install, and wire-up all auxiliary devices such as interposing current or voltage transformers, timing / switching / lockout / auxiliary relays synchro-check relay as required for the proper functioning of the schemes offered.

2. Provision shall be kept in the relay panels for hooking up with Data Acquisition System (DAS), SMS and station DDCMIS.

5.09.00 **Tariff Metering Equipment**

5.09.01 Availability Based Tariff Metering Panels

SR. NO	ABT PANEL	TYPE	QUANTITY (IN SET)	LOCATION
a)	Line Feeders	Simplex Vertical	Six (6) sets One set for each line	SWYD Control

SR. NO	ABT PANEL	TYPE	QUANTITY (IN SET)	LOCATION
			containing Main + Check+ Third Meter	Room
b)	GT Bay	Simplex Vertical	Three (3) sets, One set (1) for each GT Bay containing Main + Check + Third Meter	SWYD Control Room
c)	ST Bay	Simplex Vertical	Three (3) sets, One set (1) for each ST Bay containing Main + Check + Third Meter	SWYD Control Room
d)	Inter-Connecting Transformer (1500 MVA)	Simplex Vertical	Two (2) sets, One set (1) for each ICT Bay containing Main Meter for HV side ICT+ Check Meter for LV side ICT	SWYD Control Room
e)	Inter-bus Transformer (30MVA)	Simplex Vertical	Two (2) sets, One set (1) for each ICT Bay containing Energy Meter	SWYD Control Room
f)	Bus Rector Bay	Simplex Vertical	Three (3) sets, One set (1) for each Bus Reactor Bay containing Main + Check + Third Meter	SWYD Control Room
g)	Generator Side	Simplex Vertical	Three (3) sets, One set (1) for each Generator containing Main + Check Meters	Central Control Room
h)	UT Side	Simplex Vertical	Six (6) nos. One no. (1) for each UT containing Energy Meter	Central Control Room
i)	Excitation Transformer Side	Simplex Vertical	Three (3) nos., One no. (1) for each Excitation Transformer (if applicable) containing Energy Meter	Central Control Room

Actual quantity of ABT complied Metering Panel shall be decided during detail engineering. Meters of more than one similar bays may be accumulated in one vertical panel subject to acceptance of the same by ultimate owner during engineering stage. ABT meters shall be as per IEEE/ANSI C50.41-2000.

5.09.02 Each Feeder Bay Terminals will be provided with high precision grade (class 0.2S or better) microprocessor-based four quadrant MWh and MVARh meters provided with re-transmitting contacts for either direction (import & export for Line Bays) for Owner's main metering. The main meters shall be housed in lockable / sealable panel. Dedicated CT/VT cores of 0.2S/0.2 class of accuracy shall be used for tariff metering. The CT/VT leads for tariff metering shall be routed through dedicated junction boxes with suitable sealing arrangement.

5.09.03 The meters will be capable of giving the maximum demand indication (MDI) in MW, MVAR, MVA and will have a sealable arrangement. It will be possible to reset the maximum demand at the end of each billing period.

5.09.04 Summation (Common for the Various Bays)

1. The pulse output from individual line bay energy meter shall be connected to the summator (tele-counting instrument), which will summate the output of all line bay meters. The summator will calculate coincident net MWH, demand, net MVARh, on hourly basis. The summator of main and check tariff metering scheme shall be connected to the computer system which will compare data automatically at predefined intervals. Central computer system shall record and print the data, compare main and check tariff metering and process the data for report formation for billing purpose.

2. The summator will be solid-state type of tele-counting instrument and flush mounted version. The tele-counting instrument will be suitable for operation on 240V AC.

3. Following parameters will be recorded for integrating period (hourly basis) as well as billing period:-

   i) Total MWh import summated for all feeders
   ii) Total MVARh import for all feeders
   iii) Total MWh export for all feeders
   iv) Total MVARh export for all feeders
   v) Net MWh import - export
   vi) Net MVARh import - export
   vii) Net MVAh import - export
   viii) MVA max. demand
   ix) It shall also measure voltage, current, power factor, kW, kVAR, kVA etc.
   x) Facility for downloading the data

4. All the necessary equipment shall be provided at the switchyard control room for interfacing of telemetering through PLCC

5. Communication interface will be provided by a MODEM card for data transmission. Time of the day (TOD) facility will be incorporated with the energy meters / telecounting instruments.

6. The metering system shall have the facility to register the summated export and import of active and reactive energy on hourly-integrated period, with a minimum storage facility for 35 days.

7. Tariff metering and associated CTs & PTs shall comply with the requirements of CEA regulations on installation and operation of energy meters and shall also comply with the requirements of grid authorities

5.10.00 **List of Protections**

5.10.01 The following are the minimum principal protections, which shall be in different relay panels. The protections shall be furnished with necessary accessories like timer, auxiliary relays, interposing CTs and VTs, tripping relays, supervising relays, fuse failure relay, distance relay, master relay, relay testing, etc. as required fulfilling the functional requirements of control, indication, interlocking and protection. Any other protective relay which is required for protection of the equipment shall be given.

Sl No		Protection / Relay Application	Device No.
A	***LINE PROTECTION RELAY PANEL (main-1 and main-2 relays shall be of different make and working on different principles)***		
	1.	Main-I protection scheme (composite numerical distance and line differential protection relay (non-switched scheme) with auto re-closing and check synchronizing facility)	21M1 & 87L1
	2.	Main-II protection scheme (composite numerical distance and line differential protection relay (non-switched scheme) phase comparison relay with auto re-closing and check synchronizing facility)	21M2 & 87L2
	3.	Composite numerical directional over current (instantaneous / IDMT) and earth fault relay	67 / 67N
	4.	Over-voltage / under-voltage protection relay	59/27
	5.	Disturbance recorder (if not available in the distance and line differential protection or main protection module)	DR
	6.	Distance-to-fault locator for phase and earth faults (if not available in distance and line differential protection or main protection)	----
	7.	PT selecting relays or switches (depending on switching scheme	----
	8.	Auxiliary relays for carrier supervision of main-I and main-II protection relays (depend on its application)	30
	9.	Carrier receive lock out relay (depending on its application)	----
	10.	Breaker failure protection relay	50Z
	11.	Trip circuit pre & post-supervision relays for trip coil-I and coil-II	96
	12.	Flag relays for circuit breaker troubleshooting	----
	13.	Over-fluxing relay	95
	14.	Over frequency / under frequency relay	81
	15.	df/dt and dv/dt relay IRIG port for time synchronization	df/dt
B	***BUSBAR PROTECTION PANEL***		
	1.	Busbar differential protection Main-1	87BB1
	2.	Busbar differential protection Main-2	87BB2
C	***GENERATOR TRANSFORMER BAY PROTECTION PANEL***		
	1.	3 phase 2-stage directional phase over current protection & earth fault protection with negative	67 / 67N

		sequence polarizing	
	3.	3 phase 2-stage non-directional phase over current & earth fault protection	51 / 51N
	4.	Local Breaker Back-up (LBB) Protection Relay	50Z
D	***STATION TRANSFORMER BAY PROTECTION PANEL***		
	1.	Transformer differential protection with harmonic restraint, biasing feature	87T
	2.	Overhead Line Differential Protection (Separate Relay)	87 OH
	3.	Restricted earth fault protection on LV1/LV2 side	64RLV 1/LV2
	4.	Restricted earth fault protection on HV side	64RH V
	5.	High set instantaneous & Non-directional IDMT 3-phase over-current protection	50 / 51
	6.	Directional earth fault protection	67N
	7.	Standby earth fault protection along with high set instantaneous unit	51N / 50N
	8.	Local Breaker Back-up (LBB) Protection Relay	50Z
	9.	Buchholz (63), winding temperature (49WT) and oil temperature (490T) protections, pressure relief protection (63PTX), Rapid Pressure Rise Protection Trip, fire protection trip (both from HVWS and NIFS system)	63,49
	9.	Over-fluxing protection (To be fed from 400 KV Bus VT)	99
E	***INTER BUS TRANSFORMER BAY PROTECTION PANEL***		
	1.	Transformer differential protection with harmonic restraint, biasing feature	87T
	2.	Restricted earth fault protection on LV side	64RLV
	3.	Restricted earth fault protection on HV side	64RH V
	4.	High set instantaneous & Non-directional IDMT 3-phase over-current protection	50 / 51
	5.	Directional earth fault protection	67N
	6.	Standby earth fault protection along with high set instantaneous unit	51N / 50N
	7.	Local Breaker Back-up (LBB) Protection Relay	50Z
	8.	Over-fluxing protection (To be fed from 400 KV Bus VT)	99
	9.	Buchholz (63), winding temperature (49WT) and oil temperature (490T) protections, pressure relief protection (63PTX), Rapid Pressure Rise Protection Trip, fire protection trip (both from HVWS and NIFS system)	63, 49
F	***INTER CONNECTING TRANSFORMER BAY PROTECTION PANEL***		
	1.	Transformer differential protection with harmonic restraint, biasing feature	87T
	2.	Restricted earth fault protection	64R
	3.	IDMT 3-phase over-current protection	51
	4.	Neutral side back up IDMT earth fault protection	51N
	6.	33kV side earth fault protection (voltage based relay)	59NU

	7.	Instantaneous over current protection for zig zag Transformer	50
	8.	Instantaneous Earth Fault Protection on HV Side	50N
	9	Buchholz (63), winding temperature (49WT) and oil temperature (490T) protections, pressure relief protection (63PTX), Rapid Pressure Rise Protection Trip, fire protection trip (both from HVWS and NIFS system for Inter Connecting Transformer)	63,49
G	***BUS/LINE REACTOR BAY PROTECTION PANEL***		
	1.	Reactor Differential Protection Relay (Covering GIS TEED portion)	87R
	2.	Restricted Earth Fault Protection Relay	64R
	3.	Standby Earth Fault Protection Relay	51NR
	4.	Back-up Impedance Protection	21R
	5.	Local Breaker Back-up (LBB) Protection Relay	50Z
	6.	Reactor protection – Thermal Imaging, OTI, WTI, PRV, MOG, Buchholz, and status indications, etc.	

Apart from aforesaid Relays for Protection, there shall be Bay Control Units for each bay including Tie Bay.

5.11.00 **Protection Requirements**

5.11.01 The bidder shall furnish, install and co-ordinate the settings of all relays to suit the requirements of protection, operation and interlocks.

5.11.02 Required protections have been generally indicated hereunder for bidder's reference.

5.11.03 All relay panels for GIS shall be installed inside the air-conditioned control room which will be located in the switchyard. All Numerical relays shall have dual redundant Ethernet ports with parallel Redundancy protocol (PRP). All Numerical relays shall have necessary conformal coating and shall be capable of working in Harsh Tropical Environment.

5.11.04 Line Protection

1. The line protection relays shall protect the line and clear the faults on line in the shortest possible time with reliability, selectivity and full sensitivity to all types of line fault. The general concept for 765KV & 400KV level is to have primary and back-up protection systems having equal performance requirement especially in respect of time as would be provided by two main protections called Main-I and Main-II. It is desirable that Main-I and Main-II protection should be of two different make & algorithm and work on two different principles of operation.

2. The signals from the protective relays shall trip all the three poles. Trip impulses shall go to both the trip coils simultaneously thru' separate potential free contacts.

3. Both Main 1 & Main 2 relays shall have both Distance Protection (21M1 & 21M2) as well as Line Differential Protection (87L1 & 87L2) elements. Line Differential Protection Element (87L) shall be enabled in the relay during detailed engineering stage, if the line length is shorter (As per CEA/PGCIL/OPTCL requirement). Supply of Differential Protection relay for each line feeder (both 765kV and 400kV) at remote end are in bidder's scope

4. **Numerical Distance Protection Relay**

a) shall be numerical type and shall have continuous self-monitoring and diagnostic feature.

b) shall be non-switched type with separate measurements for all phase to phase and phase to ground faults.

c) shall have 5 zones including one for reverse zone stepped time-distance characteristics.

d) shall have mho or quadrilateral or other suitably shaped characteristics for zones.

e) The relay shall have an adjustable characteristics angle setting range of 30-85 deg and shall have independent resistance (R) and reactance (X) setting.

f) shall have two independent continuously variable time setting range of 0-3seconds for Zone-2 and 0-5 seconds for Zone-3 & Zone-4.

g) shall have resettling time of less than 55milli-seconds (including the resetting time of trip relays).

h) shall have facilities for offset features with adjustable 10-20% of Zone-3 setting.

i) shall have variable residual compensation.

j) Reach should not be affected by mutual coupling effects in the case of double circuit lines.

k) shall have memory circuits with defined characteristics in all three phases to ensure correct operation during close-up 3-phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero-volt 3-phase fault.

l) shall have weak end in-feed feature.

m) shall be suitable for single and three phase tripping.

n) shall be suitable for use in permissive under reach / over reach / blocking communication mode.

o) shall have suitable number of potential free contacts for carrier aided tripping, auto re-closing and data acquisition system / SMS interfacing

p) have suitable setting range to encircle the distance protection described above.

q) block tripping during power swing conditions.

r) shall include power swing detection feature for selectively blocking, as required.

s) shall include suitable fuse-failure protection to monitor all types of fuse failure and block the protection.

t) shall include load encroachment prevention feature like Load blinder

u) Each 765KV & 400kV line shall be provided with the main-I & main-II line differential protection. The hardware platform of Main-II shall be different from that of the Main-I protection. 33KV Line shall be provided with over-current protection.

v) Each phase current shall be separately evaluated at both end for both amplitude and phase.

w) The measurement shall be stabilized phase by phase for CT saturation & be compensated for line CT ratio mismatches.

x) shall have phase selectivity without compromise on resistive fault sensitivity.

y) Shall be suitable for single phase tripping and auto-reclosing.

z) The relay shall have communication port for remote monitoring, programming and control.

aa) The message transmitted by the relay to other end shall include information on currents, supervision information, CT saturation detection, synchronization of terminals etc.

bb) The direct inter-trip signal also shall be transmitted as part of communicated information.

cc) The communication delay shall be continuously measured and automatically compensated for the differential measurement. Communicated message shall have error detection and correction feature.

dd) Suitable programmable evaluation algorithm shall be provided to ensure proper security and dependability of the message.

ee) An optional electrical or optical port shall be provided to directly connect the signal to auxiliary channel of OLTE (optical line terminal equipment) by passing the multiplexer for redundancy purpose.

ff) The sampling frequency for analog signals shall be minimum 2 kHz. Filtering and measuring techniques shall be used to ensure correct performance during all operating and transient conditions.

gg) Shall have self-diagnostic features & GPS time synchronization facility.

hh) Relay shall have Programmable Scheme Logic to customize the device to meet the exact protection and control scheme requirements of the bay.

ii) The protection shall include the following additional functions:
- Phase segregated Distance feature
- Power Swing blocking protection
- Switch on to fault protection

5.11.05 Directional Over Current & Earth Fault Protection Relay

1. Shall have three over current and one earth fault element(s) which shall be either independent or composite units.

2. Shall be numerical type.

3. Shall include necessary VT fuse failing relays for alarm purposes.

4. **Directional Over Current Relay**

a) shall have IDMT characteristic with a definite minimum time of 3.0seconds at 10 times setting.

b) shall have a variable setting range of 50-200% of rated current.

c) shall have a characteristic angle of 30/45 degree lead.

5. **Directional Earth Fault Relay**

a) shall have IDMT characteristic with a definite minimum time of 3.0seconds at 10 times setting.

b) shall have a variable setting range of 20-80% of rated current.

c) shall have a characteristic angle of 45/60 degree lead.

5.11.06 **Auto Reclosing Relay**

1. The auto reclosing relay shall

a) be Numerical type

b) have single phase or/and three phase reclosing facilities.

2. have a continuously variable single phase dead time range of 0.1 – 2 seconds.

3. have a continuously variable three phase dead time range of 0.1 – 2 seconds.

4. have a continuously variable reclaim time range of 5-25seconds.

5. incorporate a four-position selector switch from which single phase/three phase/single and three phase auto reclosure and non- auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.

6. have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.

7. be of single shot type.

8. have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers.

9. include check synchronizing relay which shall

10. have a time setting continuously variable between 0.5 – 5seconds, with a facility of additional 10seconds.

11. have a response time within 200milliseconds with the timer disconnected.

12. have a phase angle setting not exceeding 35degree.

13. have a voltage difference setting not exceeding 10%.

14. include dead line charging relay which shall

15. have two sets of relays and each set shall be able to monitor the three phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.

5.11.07 **Line Over Voltage Protection Relay**

1. The line over voltage relay shall

a) be numerical type.

b) monitor all three phases.

2. have two independent stages and stage-1 relay is acceptable as built in with line distance relay.

3. have an adjustable setting range of 100-170% of rated voltage with an adjustable time delay range of 1 to 60seconds for the first stage.

4. have an adjustable setting range of 100-170% of rated voltage with a time delay of 100-200milli seconds for the second stage.

5. be tuned to power frequency.

6. provided with separate operation indicators (flag target) for each stage relays.

7. have a drop-off to pick-up ratio shall be 98% and above

8. provide separate out-put contacts for each 'Phase' and stage for breaker trip relays, event logger and other scheme requirements.

5.11.08 **Distance to Fault Locator**

1. The relay shall be numerical type

2. be electronic or microprocessor based type.

3. be 'On-line' type.

4. Be suitable for breaker operating time of 2 cycles

5. Have built-in display unit.

6. The display shall be directly in percent of line length or kilometers without requiring any further calculations.

7. Have an accuracy of 3% or better for the typical conditions defined for operating timings measurement of distance relays.

8. The above accuracy should not be impaired under the following conditions:-

   a) Presence of remote end infeed
   b) Predominant DC component in fault current
   c) High fault are resistance
   d) Severe CVT transients
   e) Shall have mutual zero sequence compensation unit if fault locator is to be used on double circuit transmission line.
   f) Built in feature of time distance relay is acceptable provided the requirements of above clauses are met.

5.11.09 **Bus bar Protection**

1. 765KV & 400kV bus bar shall be covered with a duplicated de-centralized high-speed bus bar protection scheme connected to two different CT cores. This shall constitute main and check differential features for 765kV & 400KV system and shall be engineered such that operation of both main & check features connected to faulty bus shall result in tripping of the same. The scheme shall be provided with necessary expansion capacity and interfaces for adding features when the switchyard is extended in future to its ultimate capacity.

2. Modular construction and have features of self-monitoring facility to ensure maximum availability. Relay shall be numerical biased differential type with operating and restraining feature.

3. have maximum operating time upto trip impulse to trip relay for all types of faults of 15miiliseconds at 5 times setting value.

4. operate selectively for each busbar.

5. provide hundred percent security upto 63kA for 400KV and 50kA for 765KV.

6. incorporate check feature.

7. incorporate continuous supervision of CT secondaries against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate alarm.

8. Be of phase segregated and triple pole type and provide independent zones of protection for each bus (including transfer bus if any). If a bus section is provided then each side of the bus section shall have separate busbar protection scheme.

9. shall not give false operation during normal load flow in busbars.

10. incorporate clear zone indication.

11. include high speed tripping relays (hand reset type) and all other auxiliary relays having adequate contacts as required to make a comprehensive scheme and other functions like disturbance recorder, event logger etc.

12. include continuous DC supplies supervision.

13. avoid CT switching.

14. shall have necessary auxiliary relays to make a comprehensive scheme.

15. No ICT shall be used for CT ratio correction

16. Check zone protection for 765KV & 400kV bus.

17. The busbar protection scheme offered shall be furnished by the bidder along with his bid.

5.11.10 **Breaker Failure Protection Relay**

1. The relay shall be numerical type

2. be triple pole type.

3. be of solid-state type

4. Duplicated LBB protection function shall be provided each EHV CBs. (Relay shall be initiated by both goose and hardwired signal)

5. Have an operating time of less than 15milli seconds.

6. Have a resetting time of less than 15milli seconds.

7. Have three over current elements.

8. Be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer, reactor equipment protections.

9. Have a setting range of 20-80% or rated current.

10. Have a continuous thermal withstand two times rated current irrespective of the setting.

11. Have a timer with continuously adjustable setting range of 0.1-1seconds.

12. Have necessary auxiliary relays to make a comprehensive scheme.

13. For all EHV CBs, a repeat trip command with 50 msec interval shall also be given to primary breaker.

5.11.11 **Tripping Relay**

High Speed Tripping Relay shall be as follows:

1. Instantaneous (operating time not to exceed 10 milli-seconds).

2. reset within 20 milli seconds.

3. D.C. operated.

4. have adequate contacts to meet the requirement of scheme, other functions like relay, LBB relay as well as cater to associated equipment like event logger. Disturbance recorder, fault Locator, etc.

5. be provided with operation indicators for each element

5.11.12 Transformer protections shall be grouped such that

1. Differential and Backup Earth fault is realized in Group A relay

2. REF & Back up Over current is achieved in Group B relay.

Similarly Transformer protection viz WT, OT, PRV, Buchholtz and surge relay protections shall also be grouped in Group-A, Group-B suitably.

Group A and B protections shall be connected to separate DC source / separately fused supplies. DC sources shall be supervised.

Both Gr A and Gr B protections shall give out tripping impulses to HV, MV and LV (as applicable), circuit breakers

5.11.13 **Differential Relay (87) (For ST, ICT, IBT & Bus/Line reactor)**

1. Have an operating time not greater than 30 ms at 5 times of rated current

2. The scheme shall have facility for ratio and phase angle correction either through auxiliary transformer or through in-built provisions.

3. High speed percentage differential relay with harmonic restraint shall be provided for transformer differential protection.

4. The relay shall have a high set instantaneous trip attachment for clearing heavy internal fault.

5. The relay shall be capable of compensating mismatch due to CT saturation during heavy through fault and to ensure stable operation.

6. The harmonic restraint feature shall ensure its stability on magnetising inrush without sacrificing its speed of operation for internal fault.

7. For transformer with On-load tap changer, relay characteristic shall be such that relay setting need not be changed between extreme tap positions.

5.11.14 **Restricted Earth Fault Relay (64R)**

1. Restricted ground fault protection shall be used to guard against ground fault in earthed neutral transformer.

2. The relay shall be instantaneous high stability circulating current type.

3. The relay shall be unaffected by uneven CT saturation during through-fault or by presence of DC component in the fault current.

5.11.15 **IDMT O/C & E/F Relay (51 & 51N)**

1. A set of phase and ground O/C relays shall be furnished as specified to act as a back-up of main protection.

2. The relays shall have inverse definite minimum time current characteristics with adjustable settings as follows:-

Ground fault current	-	10 to 40%
Phase overcurrent	-	50 to 200%

3. Where specified, the overcurrent relay shall be provided with an high set instantaneous unit (50) with a range of 500-2000%.

4. As an alternative to IDMT relays bidder may also offer definite time delay relays.

5.11.16 **Over Fluxing Relay (24V/F)**

1. The relay shall operate on the principle of measurement of voltage to frequency ratio and shall be phase to phase connected. The relay inverse time characteristic shall be compatible with transformer over fluxing withstand capability, for tripping. Independent alarm shall be provided with delay on actuation.

2. 1st set of time delay unit should give alarm and 2nd set of time delay unit is to trip the main and tie breaker. Necessary auxiliary relays as required to complete the scheme shall be provided.

5.11.17 **Trip Circuit Supervision Relay (96)**

1. The relay shall be capable of monitoring the healthiness of each 'phase' trip circuit of circuit breaker during 'ON' and 'OFF' conditions.

2. The relay shall be numerical type / static.

3. The relay shall have adequate contacts for providing connection to alarm and event

4. The relay shall have time delay on drop-off of not less than 200milli seconds provided with operation indications for each phase.

5. These supervision relays shall be fed from two separate DC sources.

5.11.18 **Lockout Relay (86)**

1. Lockout relays shall be fast operating, hand reset type with multi-contacts for a number of switching operations.

2. The relays shall be designed for a high degree of mechanical stability and shall have heavy duty contacts. 12 NO + 6 NC minimum contacts shall be furnished per relay.

5.11.19 **Lockout Supervision Relay (74)**

1. Each lockout relay circuit shall have supervision relay which will initiate alarm in case of any trouble in lockout circuit/relay.

2. This relay shall be properly coordinated with the characteristic of lockout relay to prevent any mal-operation.

5.11.20 **CVT/ VT Supervision Relay**

Each core of CVT/VT shall be provided with three pole under voltage relays for fuse failure supervision. Alarm shall be initiated on failure of any CVT/VT core, Mal-operation shall be prevented in the event of a fuse blowout.

5.11.21 **DC Supply Supervision Relay**

1. The relay shall be capable of monitoring the failure of DC supply to which, it is connected.

2. It shall have adequate potential free contacts to meet the scheme requirement.

3. The relay shall have a time delay on drop-off of not less than 100milli seconds and be provided with operation indicator/flag.

5.11.22 **Flag Relays**

1. hand reset flag indication.

2. have minimum two contacts (NO or NC or combination as required) for each relay.

5.11.23 **Disturbance Recorder**

The DR shall meet the following specification

1. Sampling rate of 6.4 kHz to allow accurate recording of the analogue and digital signals during a fault condition

2. Analogue to digital conversion of 16 bits (65,536 digital levels) for accurate reproduction of the fault at low signal levels.

3. Built In digital signal processor (DSP) to provide calculated quantities such as MW, MVAR, Frequency, Phase Angle, NPS, PPS etc.

4. Cross-Triggering feature so all connected IDM units will trigger and provide information across the complete substation during a fault condition.

5. Built-in GPS receiver for accurate time stamping of date to 1microsecond and to provide synchronized sampling across the entire power system records from multiple sites can be compared accurately for system wide disturbances.

6. Memory of the DR shall be 16Mbyte and allows for up to 50seconds of recording time for multiple triggers.

7. Recording times are user selectable up to 20,000msec in the DR.

8. Retrieval of the fault data from the DR shall be possible both locally and remotely using Ethernet TCP/IP at 10Mbits/sec.

9. Simultaneous recording of signals in slow scan mode (10/50Hz) for up to 25minutes around the fault time to information regarding the system stability and frequency variations.

10. Simultaneous recording of signals in continuous recording mode (10/50Hz). The data from such record of 15 days of continuous data shall be available for such signals as frequency, MW, MVAR etc.

11. Fibre optic connections and auto transfer of records to allow multiple DR units to share the same storage unit and local master station. For example, monitoring at 400kV panels can be made available in any convenient location.

12. The DR shall have software package dedicated to making the operation of the equipment and the analysis of the recorded data user friendly. The software shall enable correct analysis of data so that improvements to the network can be justified.

13. Power Quality Monitoring, to meet the European EN51060 standard, shall be available as an optional feature and if required Power Quality Package (Software Upgradation) shall be available at a nominal price.

14. The offered DR shall be certified system for performing synchronized phasor measurement & providing the data in IEEE C37.118 data format.

15. The software shall be given in CD form

16. The disturbance recorder shall contain the following features:

    a) Automatic or on-request collection of data

    b) Data compression technique

    c) Calculation of distance to the fault

d) Versatile digital disturbance recorder module for recording various phenomena in the electric power system, especially during fault conditions.

e) Can be plugged into the location of any protection relay module

f) Fully self-contained recorder module, no protection relay modules needed for the function.

g) A total of eight analog channels and eight digital channels can be supervised by one disturbance recorder module.

h) Increased recording capacity by reducing the number of channels recorded.

i) The total recording time can be divided into shorter parts

j) Triggering by over current, over voltage, under voltage or by rising or falling edge of a binary signal

k) Triggering also possible via a serial communication command given manually with push buttons on the front panel or automatically at certain time intervals.

l) Time-tagged events obtained from a built in real-time clock with battery back-up.

m) The history part of the recording, that is the part preceding triggering, can be set within 0-100% of the total recording time.

n) Maximum and minimum values of voltages and currents recorded in a separate limit value register.

o) Events such as triggering, exceeding of limit values and changes in binary signal status are recorded in a log register.

p) Settings and recordings retained during an auxiliary supply failure.

q) Easy-to-use PC software available for setting recorder parameters, reading recorded data and printing out recordings.

5.11.24 The relay characteristics shall compensate for uneven saturation of C.T.s on heavy through faults and shall ensure stable operation.

5.11.25 The relay shall not be affected by harmonics and D.C. components of the fault current.

5.12.00 **Laptop Configuration and Synchronizing Trolley**

5.12.01 Laptop industrial grade configuration shall have features as mentioned in the C&I specification.

5.12.02 **Indicative List of Major Devices Mounted in Synchronizing Trolley**

Sl No	Description	Quantity
1	Double Voltmeter	1
2	Double Frequency meter	1
3	Synchroscope	1
4	Lamp for bright lamp synchronization	2
5	Reversing VT	1

NOTES: This list is indicative and meant for general guidance of the bidder only

5.13.00 **Lightning Arresters (AIS)**

5.13.01 The following Specification covers the design, manufacture, assembly, testing at manufacturer's works, supply & delivery of LIGHTNING ARRESTERS complete with all materials and accessories for efficient and trouble-free operation in a manner acceptable to Owner.

5.13.02 The equipment will be used in 765KV, 400KV & 33KV switchyard having characteristics as detailed in specification.

5.13.03 The equipment will be installed outdoor in a hot, humid and tropical atmosphere with heavy pollution.

5.13.04 All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.

5.13.05 The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

5.13.06 The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.

5.13.07 There shall be no radio interference when the equipment is operated at maximum service voltage.

5.13.08 The safety clearances of all live parts of the equipment shall be as per relevant standards.

5.13.09 Arresters shall be designed with sufficient cantilever strength to meet with stress due to wind pressure and short circuit forces arising from rated short time current.

5.13.10 The lightning arrester shall be installed as close to the equipment as possible and also on the line entrance.

5.13.11 **Type and Rating**

1. Lightning arrester shall be station class, heavy duty, and metal-oxide gapless type with ratings as detailed in the Annexure - D.

2. The arrester shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes.

5.13.12 **Constructional Features**

1. The arrester shall be single pole, hermetically sealed, of robust construction with excellent electrical, thermal and mechanical characteristics even after repeated operation.

2. Insulator shall be wet process porcelain, brown glazed and free from imperfections. All metal parts and hardware shall be hot dip galvanised.

3. Creepage distance shall correspond to very heavily polluted atmosphere (31mm/kV). Grading ring, if required, shall be provided to maintain voltage gradient within permissible limit.

4. The arrester shall be provided with pressure relief device to prevent shattering of porcelain in case excessive gas pressure builds up.

5.13.13 **Accessories**

1. Lightning arrester shall be furnished complete with insulating base, arrester connector, surge counter, leakage current monitor knife switch and anchoring hardware for mounting on steel structure.

2. The surge counter shall be suitably enclosed for outdoor duty and be mounted at a convenient height for reading. Counter terminals shall be such as to permit connections with minimum possible bends. No auxiliary power supply or battery shall be required for operation of counter.

3. A leakage current detector shall be furnished with the counter as an integral part. This is for monitoring the leakage to indicate any possible breakdown. Readings of mili-ammeter and counter shall be visible through inspection glass panel .Provision shall be made to interface the leakage current indication in the SAS.

4. A suitably sized by-pass shunt along with necessary terminals shall be furnished for bypassing the discharge counter if required.

5. Grading ring / corona ring as applicable for the particular voltage class of arrester shall be provided.

5.13.14 **Terminals**

1. All connection terminals shall be of corrosion resistant material and complete connection hardware.

2. All ground terminals shall have provision of connection to G.I. flat of approved size.

5.13.15 **Routine Tests**

During manufacture and on completion, the lighting arresters in complete shall be subjected to the Routine Tests as laid down in latest revision of IEC/IS including functional (operational) tests on the surge counter.

5.13.16 **Type Tests**

1. Valid Type test reports shall be submitted for lightning arrester of each voltage class according to latest revision of IS 15086/IEC 60099.
2. In addition, radio interference voltage (as per IS: 8263) valid test report shall also be submitted for lightning arrester of each voltage class

5.13.17 **Special Test**

1. Special thermal stability tests to be conducted on lightning arresters according to IEC, as an acceptance test.

2. Temperature cycle test on the porcelain housing of the arrester to be conducted as per IS/IEC

3. The artificial pollution test shall be carried out as per applicable standards.

4. The galvanization test on metal parts shall be carried out as acceptance test.

5. The functional (operational) acceptance tests shall be carried out on the surge counter.

6. Valid Type test certificates on any equipment, if so desired by the Owner, shall be furnished for owners review. In case of non-availability of valid test certificate, contractor shall conduct type tests as per IS / IEC without any additional commercial implication to prove the design.

7. The test report shall furnish complete identification of the equipment such as serial no., rating, equipment designation and date of test.

5.14.00 **Wave Traps (AIS)**

5.14.01 The equipment will be used in 765KV & 400 kV system and will be a part of PLCC system.

5.14.02 The equipment will be installed outdoor in a hot, humid and tropical atmosphere, suitable for mounting on post insulators (pedestal type). The wave trap shall be equipped with suitable bird barriers painted with grey colours.

5.14.03 All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.

5.14.04 The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

5.14.05 The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.

5.14.06 There shall be no radio interference when the equipment is operated at maximum service voltage.

5.14.07 The safety clearances of all live parts of the equipment shall be as per relevant standards.

5.14.08 The coil of wave trap shall be designed to tolerate the short circuit current of the line for a short period and shall withstand the mechanical stress resulting from it. HF tuning elements shall be placed in a separate sealed unit.

5.14.09 The wave trap shall be provided with a protective device which shall be designed and arranged so that neither significant alteration in its protective function nor physical damage shall result from either temperature rise of the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation following transient actuation by the power frequency voltage developed across the wave trap by the rated short time current.

5.14.10 The protective device in the form of surge arrester shall be gapless or gapped type. For proper co-ordination with the lightning arresters installed in the substation, its rated discharge current shall be 10KA.

5.14.11 **Type and Rating**

i) Wave Trap shall be outdoor type with ratings as detailed in the Annexure-E.

ii) The Wave Trap shall be broadband tuned for its entire carrier frequency range. Resistive component of impedance of the Wave Trap within it carrier frequency blocking range shall be as per Annexure - E.

iii) The coil of the Wave Trap will be designed to tolerate the short circuit current of the line for a short period and shall withstand the mechanical stress resulting from it.

5.14.12 **Constructional Features**

i) The Wave Trap shall be suitable for outdoor pedestal mounting as indicated in the Annexure – E and furnished complete with fixing hardware. Installation shall be mechanically strong enough to withstand the stresses due to maximum wind pressure as indicated in site conditions specified elsewhere.

ii) For pedestal mounting, each Wave Trap shall be mounted on a tripod structure formed by three insulator stacks arranged in a triangular form. All the accessories and hardware, mounting stool including bolts for fixing the Wave Trap on insulators shall be of non-magnetic material.

iii) For suspension mounting, each Wave Trap shall be provided with suspension ring.

iv) The main coil consists of an edge wound special aluminum alloy conductor with high mechanical strength. Several conductors may be wound in parallel depending upon the current to be handled. The aluminum end cross arms are held together with one or several non magnetic high strength tension rods.

5.14.13 **Accessories**

i) Tuning device shall be designed for single frequency, double frequency or adjustable wide band tuned with high degree of tuning constancy even under the influence of varying temperature. Tuning device shall be easily replaceable in case of operational frequency bandwidth change.

ii) Tuning device shall be so designed and arranged that neither significant alteration in its blocking requirement nor physical damage shall result from either temperature rise or magnetic field of the main coil at continuous rated current or rated short time current or emergency overload current.

iii) Wave Trap shall be provided with a protective device in the form of surge arresters. which shall be designed and arranged such that neither significant alteration in its protective function nor physical damage shall result from either temperature rise or magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation, following transient actuation by the power frequency voltage across the Wave Trap by the rated short time current.

iii) Wave Trap shall be equipped with bird barriers on top and bottom.

iv) Wave trap shall be provided with suitable corona rings to meet corona and radio interference performance.

v) Wave Trap shall be spray painted with shade 631 of IS 5 or equivalent RAL.

5.14.14 **Terminals**

i) Wave Traps shall be provided with flat pads which are welded to the cross arm for fixing the terminal connectors. No part of clamp or connector including hardware shall be of magnetic material.

ii) Clamps/ connectors shall be designed for the same current rating as Wave Trap.

iii) The bidder will consider two nos. Wave Traps at each end. The Wave Traps shall be complete and will include provision of surge arresters.

5.15.00 **Current Transformer (Tariff Metering – AIS)**

5.15.01 The equipment will be used in 765KV & 400 KV switchyard, having characteristics as listed in the Annexure - F.

5.15.02 The equipment will be installed outdoor in a hot, humid and tropical atmosphere.

5.15.03 All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.

5.15.04 The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

5.15.05 The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.

5.15.06 There shall be no radio interference when the equipment is operated at maximum service voltage.

5.15.07 The safety clearances of all live parts of the equipment shall be as per relevant standards.

5.15.08 **Type and Rating**

i) The Current Transformers shall be oil immersed, self-cooled and hermetically sealed type.

ii) Current Transformers shall have single primary – either ring type or hair pin type.

5.15.09 **Constructional Features**

i) The current transformer shall be single pole unit, designed for upright mounting on steel structure and furnished complete with fixing hardware.
ii) Insulator shall be of wet process porcelain, brown glazed and free from imperfections. All metal parts and hardwares shall be hot dip galvanised.

iii) The creepage distance shall correspond to heavily polluted atmosphere. Grading ring, if required, shall be furnished to maintain voltage gradient within permissible limit.

iv) Current transformer shall be provided with oil level gauge, drain plug and pressure relief device. An inert gas cushion/ stainless steel bellow shall be provided on top for expansion of the oil.

v) Current transformer shall be so constructed as to ensure that the oil does not flow out or leak out even when the current transformer is used continuously at the maximum allowable temperature.

5.15.10 **Terminals**

i) Primary terminals shall be made of non-ferrous corrosion resistant material and provided with bimetallic terminal connectors.

ii) All Secondary terminals shall be brought out to a terminal box and suitable for connection to 2 x 2.5 mm^2 stranded copper conductors per way.

iii) All primary and secondary terminals shall be clearly and indelibly identified as per relevant standard.

iv) The terminal box shall be of 3 mm thick sheet steel, IP-55, weather proof and dust-tight, complete with gasketted front access cover and removable gland plate at bottom for cable entry.

5.15.11 **Grounding**

i) Each current transformers shall be provided with two ground pads for connection to station ground mat.

ii) The ground pad shall comprise buffed metal surface with two holes, M10 G.I. bolts and spring washers to receive 75 mm x 10 mm G.I. flat.

5.16.00 **Capacitive Voltage Transformer (Tariff Metering – AIS)**

5.16.01 The equipment will be used in 765KV & 400 KV system, having characteristics as listed in the Annexure - G.

5.16.02 The equipment will be installed outdoor in a hot, humid and tropical atmosphere.

5.16.03 All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.

5.16.04 The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

5.16.05 The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.

5.16.06 There shall be no radio interference when the equipment is operated at maximum service voltage.

5.16.07 The safety clearances of all live parts of the equipment shall be as per relevant standards.

5.16.08 **Type and Rating**

i) Voltage Transformer shall be capacitor type, having ratios and ratings as specified in the Annexure - G.

5.16.09 **Constructional Features**

a) Voltage transformer shall be single pole unit, designed for upright mounting on steel structure and furnished complete with anchoring hardware.

b) Insulator shall be wet process porcelain, brown glazed and free from imperfections. All metal parts and hardware shall be hot dip galvanized.

c) Creepage distance shall correspond to heavily polluted atmosphere. Grading ring, if required, shall be provided to maintain voltage gradient within permissible limit.

d) CVT shall comprise a number of capacitor units mounted on a steel base containing the potential device and other accessories.

e) The capacitors shall be oil-impregnated type enclosed in an inert gas atmosphere within porcelain shell hermetically sealed.

f) Accessories housed in the steel base shall include :

i) Series reactor which along with the capacitance of the divider shall be tuned to power frequency.

ii) Device for ferro-resonance suppression.

iii) Protective gap for over voltage.

g) CVT shall be designed to cover its rated output range without any adjustment of its electromagnetic unit.

5.16.10 **Terminals**

i) Primary terminals shall be made of non-ferrous corrosion resistant material and provided with bimetallic terminal connectors.

ii) Secondary terminals shall be brought out to a terminal box and suitable for connection to 2 x 2.5 mm^2 stranded copper conductors per way.

iii) All primary and secondary terminals shall be clearly and indelibly identified as per relevant standard.

iv) The terminal box shall be of 3 mm thick sheet steel, IPW-55, weather proof and dust-tight, complete with gasketed front access cover and removable gland plate at bottom for cable entry.

v) HRC fuses, suitably sized to prevent overload, hall be installed in all ungrounded secondary leads.

5.16.11 **Wiring**

i) Wiring shall be complete in all respects to ensure proper functioning of the control, protection, monitoring and interlocking schemes.

ii) Wiring shall be done with flexible 750/1100 V grade, PVC insulated, switchboard wires with 2.5 mm^2 stranded copper conductor. Wiring between individual poles and control cubicle shall be routed through G.I. conduits.

iii) Each wire shall identified at both ends with permanent markers bearing wire numbers as per Contractor's wiring diagram.

iv) Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

v) All spare contacts of relays, push buttons, auxiliary switches etc. shall be wired upto terminal blocks in the control cubicle.

5.16.12 **Terminal Blocks**

i) 650V grade, multi way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5 mm^2 stranded copper conductor and provided with acrylic insulating cover.

ii) Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

iii) Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

iv) Terminal blocks used for interface with DDCMIS via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

5.16.13 **Earthing**

For GIS equipment, high frequency earth grid shall be provided. Dedicated Copper Earth mat of adequate size embedded in the concrete i.e. below FFL of GIS building shall be provided. Same shall be connected to below ground earth mat of GIS building. In the proposed HF earthing grid, welding of copper bars shall be made to ensure the proper continuity. The connection between below ground mat & HF earthing grid shall be made in such a way that the connection of earth grid conductors shall be intact for 30 years.

i) Each VT shall be provided with two earth pads for connection to station earthing mat.

ii) The ground pad shall comprise buffed metal surface with two holes, M10 G.I. bolts and spring washers to receive 75x10 mm G.I. flat.

iii) The earth connecting points of the equipment shall be marked with 'Earth' symbol.

5.17.00 **Communication System**

Bidder to supply both Optical fiber Ground Wire (OPGW) as well as Power line carrier Communication (PLCC) system.

5.17.01 **OPGW Terminal Equipment (both for 765KV & 400kV)**

In OPGW system the OPGW cable between the sending end take off tower & receiving end take off tower are excluded from Bidder scope. However the approach cable from the take-off tower up to the control room including all hard wares is required to be supplied by the Bidder.

To establish communication between sending and receiving stations where fiber optic communication node is available, brief specification of SDH STM-4 along with PDH Interface (Primary Multiplexer) is furnished below:

Fiber Optic SDH STM -1/4 Multiplex Equipment

1. Design Criteria

The following criteria shall be followed with respect to two nodes while designing SDH STM-1/4 FO system.

a) Multiplexer Nodes

1. The new MUX shall support hybrid switching network technology which are:

   - Circuit-Switching TDM for SDH STM-1/4 level and upgradable to STM-16
   - Packet-Switching for TCP/IP applications

2. Each Node shall support the following interfaces:

   - Optical Interfaces STM (Outbound Link)
   - V.24 RS232 serial interfaces (for IEC 60870-101 SCADA links)
   - TCP/IP Switching & VLAN function (for IEC 60870-104, IT, Energy Metering, VOIP phones).
   - 8x10/100/1000 Base TPOE Interface
   - IEEE C37.94 optical interface 850nm MM (For Tele-protection)

- I/O Teleprotection intertripping units (For Tele-protection)
- Redundant Central Processor CPU and Power Supply PSU units

3. Contractor shall provide Network Management System with necessary software and hardware.

2. General Requirements

a) The SDH system shall be designed for digital transmission using single mode optical fibres and shall conform to the ITU-T recommendations G.703, G.704, G.707, G.783 and G.957.

b) The multiplexing structure of the proposed SDH system shall allow PDH signals to be carried over the synchronous network and shall permit the extraction of individual channels, from high capacity systems without having to de-multiplex the whole system.

c) The SDH system shall be provided with direct software control of network functions and in-service provision, and comprehensive network management and distributed band width and demand facilities. In addition, remote test control and centralized alarm gathering and reporting features shall also be provided.

d) A redundant configuration for ensuring minimum down time in case of equipment failure shall be provided. Any failure shall produce automatic switch-over to the back-up unit and initiation of an alarm.

3. SDH Equipment

a) The SDH equipment shall perform both multiplexing and optical line terminating functions. The aggregate ports of the SDH equipment shall be duplicated and shall be capable of operating in a `1+1' protected mode as part of a point to point link, or as an `east/west' mode when used in a drop and insert chain in a ring. All features and functions of the SDH equipment shall be readily software configurable to suit operational requirements of the SDH system.

b) The SDH equipment shall be capable of being configured as a hub, cross connection, repeater, add/drop multiplexer or terminal multiplexer.

c) The SDH equipment shall be equipped with a range of plug-in tributary interfaces to support a comprehensive range of plesiochronous and synchronous tributaries including 2 Mb/s, 34 Mb/s and from STM-4 operation. Cross connection levels shall include 64 kb/s, VC-12, VC-3 and VC-4. The following interface card/modules shall be equipped in each of the SDH STM-4 equipment.

- Optical Interfaces STM4 (Outbound Link) Redundant mode
- V.24 RS232 serial interfaces (for IEC 60870-101 SCADA Links)

- TCP/IP Switching & VLAN functions (for IEC 60870-104, IT, Energy Metering, Fault Recorder, Power Meter, Transformer monitoring System, Relays Management, CCTV & Vo1P phones).
- 8x10/100/1000 base TPOE interface as minimum
- 2 wire FXS Iterface-16 channel for site-1 only
- 2 wire FXO Interface-16 channel for site-2 only
- 4 wire E&M voice interface-8 channel-one card for Site-1 and one card for Site-2
- IEEE C37.94 optical interfaces and electrical (For Tele –protection)
- I/O Tele-protection intertripping units (For Tele-protection)
- Redundant Central Processor CPU and Power supply PSU units

d) SDH equipment shall be located on a fibre optic backbone system that serves the major facilities within the system.

e) Details of the requirement of STM-4 with PDH interface (comprising of optical interface card/SFP, Tributary card and subscriber line interface card) shall be estimated by the Bidder based on the Line lengths.

4. Primary Access Multiplexing Equipment

a) All primary access multiplexing, de multiplexing and signal processing and conditioning equipment shall be provided to interconnect SCADA, teleprotection and telecommunication equipment to the SDH system.

b) Communication interfaces shall be capable of being made available by means of insertion of appropriate channel cards into the multiplexer rack. It is preferable that a channel card should contain all the components necessary to enable the same card to cater for as many different types of operation as possible by means of software configuration both locally and for remote site. Details of the channel cards to be supplied by the Contractor shall be included in the Tender.

5. Network Management System

a) The Network Management shall consist of one no. of Server, one no. workstation with keyboard and monitor and mouse. One no. work station with mouse, keyboard and monitor shall be used for operating software and configuration purpose. One no. craft terminal with CPU and monitor etc. shall also be required. The NMS software shall carry out all configurations of the equipment and diagnostic check.

b) Two no. of MDF-50 Pairs shall be required for two sites.

c) Details of the requirement of Network management System and MDF shall be estimated by the Bidder based on the line lengths.

i. Bidder to consider different station as the destination of 400kV lines.

ii. All communication equipment provided shall be SDH-STH-16 and should be suitable for 24 fibre OPGW.

5.17.02 **Power Line Carrier Communication (PLCC) Equipment**

The Power Line Carrier Communication Equipment shall provide secure and reliable information link for carrier aided distance protection and direct tripping of remote end breaker at PGCIL/OPTCL's sub-station. The equipment will be used in line feeders of 765KV & 400 KV.

The PLCC system shall basically comprise the following equipment but not limited to the same:

i) Wave Traps
ii) Capacitive voltage divider type Voltage transformer (CVT)
iii) Carrier Connection
iv) Coupling Device
v) Coupling Filters
vi) Drainage of Charging Current
vii) Insulation
viii) High Frequency Cables
ix) PLCC Communication Equipment
x) Speech Communication
xi) Network Protection equipment (Protection Coupler)
xii) Power Line Carrier Terminals
xiii) Testing and Maintenance Equipment
xiv) 48V D.C. Power supply equipment

The PLCC system shall be suitably designed to work over the 765KV & 400 kV high voltage overhead power transmission lines and shall comply with IEC 495 latest version. The system shall operate satisfactorily under all power system switching and weather conditions.

Bidder shall quote for the complete set of equipment with latest designs complete with all equipment, co-axial cabling as applicable and other terminal equipment like receivers, supervision and alarm circuits, protection coupler and modems as needed to make the system complete in all respects.

Wave Trap (WT)

Wave trap is not be a separate item. The item is already described earlier under clause no. 5.14.00.

Capacitive voltage divider type Voltage transformer (CVT)

This is not be a separate item. The item described under clause no. 5.01.03 above shall be used for the same. The voltage transformer shall be capacitor voltage divider type with Electro-magnetic (EM) units and shall be suitable for carrier communication apart from stepping down the voltage for measurement/ protection purpose. The secondary of CVT shall be protected from flowing into the metering circuit by means of RF choke/reactor. HV terminal shall be brought out through suitable bushings. The EM unit shall have separate terminal box with all secondary terminals brought out. A protective surge arrester / spark gap shall be provided to prevent breakdown of insulation and to limit abnormal rise of terminal voltages. All ferrous metallic parts and surfaces shall be hot dip galvanized.

Carrier Connection

a) The carrier lead shall be brought out of steel base through high frequency bushing. Carrier terminal shall be kept earthed if not used.

b) Additional protective devices for carrier equipment shall be furnished as follows :

   i) Drain Coil
   ii) Lightning Arrestor
   iii) Grounding Switch

c) These protective devices shall be complete with hardware for mounting on CVT support structures.

Coupling Device (Line Matching Unit and Protective Devices)

Coupling capacitor shall be used for linking the overhead line to the carrier communication and protection equipment. It shall comprise single-phase units made of series connected capacitor elements contained in porcelain housing. These shall be suitable for the entire carrier frequency range of 40 KHz to 500 KHz. Natural frequency of the coupling capacitor should be well above the highest frequency.

The coupling device shall be interposed between the CVT and the co-axial line to the PLCC transmitter/receiver. Two nos. phase to earth type coupling filters shall be used to achieve phase to phase coupling. The coupling device in conjunction with the CVT shall form an electric filter of high pass type.

It shall ensure efficient transmission of carrier frequency signals between the carrier frequency connection and the power line. It shall also ensure safety of personnel and protection of the low voltage parts and installation against the effects of power frequency voltage and transient over-voltages..

Coupling Filters

Coupling filter in conjunction with the capacitance of the capacitor voltage transformers shall constitute a broadband pass type filter. It should match the characteristic impedance of the high-tension line with impedance of the connection line for PLCC transmitter/receiver.

Drainage of Charging Current

The primary of the coupling unit shall have low impedance or operating frequency of the power line (50 Hz.) so that the capacitor charging current of the CVT is grounded.

Insulation

The matching transformer of the coupling device shall introduce a galvanic isolation between the input and output circuits of the device and should be able to withstand a test voltage of at least 3 KV rms. for 1 minute.

The coupling device shall also be provided with a protective device, which shall protect the carrier equipment against excess voltage in the event of capacitor voltage transformer getting defective.

High Frequency Cable

High frequency cable shall connect the coupling device installed in the switchyard to the PLC terminal installed indoors. The high frequency cable to be offered by the contractor shall be suitable for being laid directly to the ground or in trenches or in ducts. The cable shall be PVC sheathed and GI wire armoured and its outer surface protected from attacks from termites. The capacitance of the cable shall be low so as to minimise attenuation at the carrier frequency range. Impedance of the cables shall be such that to match the output impedance of the PLCC terminal on one side and to that of the coupling devices (LMU) on the other side, over the entire carrier frequency range of 40 to 500 kHz. The cable shall be insulated to withstand a test voltage of 4 KV rms. for one minute between conductor & outer sheath. Bidder shall offer Co-axial H.F. cable with 75 Ohms impedance (unbalanced).

Bidder shall furnish the values of attenuation per KM for the high frequency cables offered at various values of carrier frequencies in the range of 40 KHz to 500 KHz.

The maximum attenuation at various frequencies shall be as follows :

Table: 1.0

FREQUENCY IN KHZ	ATTENUATION IN DB/KM
10	0.8
60	1.4
300	3.3
500	4.7

The H.F. cable shall conform to the latest edition of IS Publication No. 5802.

PLCC Communication equipment

The PLCC Communication equipment shall be designed to withstand an ambient temperature of 50 deg C. The terminals shall be suitable for remote subscriber application. A plug in type telephone (hand set) and buzzer shall be

provided for speech/protection purpose. The PLCC terminal shall have in-built testing facilities. It shall use amplitude modulation and shall have single side band transmission mode.

Speech Communication

The PLCC equipment offered shall be provided with telephone communication between the stations where transmission lines are terminating. The PLCC terminals shall be provided with built-in alarm circuits, fuses etc. besides other normal facilities like ring back tone, dial tone engage tone, priority tone and suitable pulses for establishing and connection between the subscribers.

Network Protection equipment (Protection Coupler)

Network Projection Equipment shall be 2 command type. The bidder shall offer voice frequency transmission equipment, which shall work on frequency shift or coded signal principle of transmission/reception of protection signals (minimum of 4 signals each type as single purpose channel. The equipment shall be suitable for connection to the power line carrier terminal. The equipment shall be designed for remote tripping/blocking on permissive basis and direct tripping. Necessary alarm function shall be included.

Power Line Carrier Terminals

Single side band PLCC terminals of latest version equipped for fixed frequency duplex system working shall be offered for superimposed channels (multipurpose) for speech, tele-metering, and tele-signalling and protection purpose. The PLCC terminals shall be complete with H.F. Hybrid filters and shall have necessary frequency stability so that adjacent channel working is possible.

The PLCC terminals shall be located at a suitable location in Switchyard Control room. The contractor shall offer high frequency companders as per relevant IEC/IS specification. Each PLCC terminals shall be mounted in floor mounting sheet metal (min 2 mm thick) cabinets. The terminals shall be provided with built in indicating instruments to facilitate checking of important voltage and signal values at different points of the PLCC terminal. Protective fuses should be provided in all important circuits and the fuses shall be so mounted as to allow their easy inspection and replacement. The carrier set shall be provided with suitable supervision and alarm facilities. The individual parts of the carrier set should be accessible from the front, making it possible to place the carrier set cabinets side-by-side, back-to-back, against wall. All component parts of the carrier set shall be suitably tropicalised and protected against bad effects of humidity, fungus etc.

The PLCC terminals shall be provided with emergency call facilities from the carrier sets for point to point carrier communication (RSI facility) with required telephone set.

The PLCC terminals should be of vermin proof and provided with, ventilating fan, if required. Necessary socketing arrangement for connection of the H.F. cable from the coupling device shall have to be provided.

System Specification

i) A lightning arrestor shall be connected as directly as possible between the primary and earth terminals and shall be capable of protecting the coupling device and the carrier frequency connection. The lightning arrestor shall have power frequency spark over voltage co-ordinated with the equipment ahead of it.

The coupling device shall conform to the following carrier frequency operating characteristics and apply to phase to earth coupling units. Typical specifications are as follows:

Table: 2.0

a)	Carrier frequency range (programmable)	40 to 500 kHz
b)	Carrier frequency range (total)	24 to 500 kHz
c)	RF output power at co-axial output	80W
d)	Nominal equipment side Impedance	150 Ohms for balanced secondary circuit or 75 Ohms for unbalanced Secondary circuit.
e)	Max. composite loss	2 dB
f)	Number of AF channels	1 to 4
g)	Effective AF bandwidth	300 to 3600 Hz

The contractor may note that composite loss is the power loss occurring in the carrier signal after passing through the coupling unit complete with CVTs. Coupling unit is supposed to be loaded with its primary and secondary impedance while capacitor is assumed to have no loss.

ii) The contractor shall specify the capacitance of the CVTs with which the coupling unit may be used for the above transmission band.

iii) Two nos. phase to earth coupling units should be capable of being used to form inter phase or interline coupling. In case any separate matching transformer or matching unit is required, the same shall be offered.

iv) The contractor shall also provide suitable earthing switches for grounding the low voltage terminals of CVT for carrying out maintenance or any other works on coupling unit.

v) The coupling device should be suitable for outdoor mounting and shall be fitted on the steel structure. Temperature of metallic equipment mounted oudoor is expected to rise upto 65deg. C during maximum ambient temperature of 50deg. C specified. The equipment offered shall satisfactorily operate under these conditions.

vi) The coupling device shall conform to relevant IEC/IS standards.

vii) The connection between coupling device and CVT shall be done by

means of 6 sq.mm. copper wire taped with 11 KV insulation.

Testing and maintenance Equipment

Bidder shall indicate in his offer the complete set of testing and maintenance equipment required for servicing the PLCC equipment at site.

48V D.C. Power Supply Equipment

The contractor shall furnish comprehensive arrangement for a stabilized 48 V DC power supply with 2X100% Lead acid plante battery, 2X100% Battery Charger, 48V DCDB, Alarm unit etc. for PLCC terminals. The Contractor's scope also includes necessary cable connection through approved route and methodology for Battery Charger connection etc. to cater the requirement.

5.18.00 **Outdoor Switchyard Materials and Hardwares**

5.18.01 The following specification covers the design, manufacture, assembly, testing at manufacturer's works, supply & delivery of switchyard materials & hardware for 765KV & 400KV switchyard materials and hardwares complete with all accessories for efficient and trouble free operation.

5.18.02 All the ACSR conductors, aluminium tube, disc and string insulators, clamps & connectors, hardware etc. will be used in extra high voltage system having characteristics as per specification.

5.18.03 All equipment, conductors, tube, hardware, insulators & clamps etc. will be installed outdoor in a hot, humid, lignite dusty & tropical atmosphere.

5.18.04 The maximum temperature in any part of the clamps, connectors, conductors etc. at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

5.18.05 All equipment, conductors, tube, clamps, connectors, insulators etc. shall be capable of withstanding the dynamic & thermal stresses of maximum short circuit current without any damage or deterioration.

5.18.06 In order to avoid concentration of stresses, all sharp edges of clamps, connectors etc. shall be rounded off with a radius of minimum 3mm.

5.18.07 Bi-metallic connectors shall be used for any connection between dissimilar materials.

5.18.08 **Equipment & Materials**

1. Equipment & material shall comply with description, rating, etc. as detailed in this specification.

2. All accessories, fittings, supports, S.S. bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

3. All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

4. After the treatment of steel surfaces damaged during transit sufficient quantity of anti-corrosive paint shall be applied and subsequently finished with two coats of final paint of approved shade.

5.18.09 **ACSR - Conductors / Tubular Aluminium Bus**

1. The aluminium stranded conductor and steel reinforced shall have the technical parameters matching with the specification requirements. ACSR conductors shall conform to the latest revision of IS-398.

2. The material of tubular aluminium bus shall be of grade 63401 WP (Range-2) of IS 5082 or equivalent having best possible combination of electrical and mechanical properties.

3. Rigid type extruded tubular aluminium bus arrangement shall be used for equipment connections.

4. Tube buses shall be provided with fixed clamp at one end and sliding/flexible type clamp on the other end for taking care of thermal expansion. Long run of tube bus shall be complete with suitable internally mounted vibration damper at intervals in order to achieve quick damping of aeolian vibrations and vibrations arising out of electro-mechanical forces.

5.18.10 **Clamps and Connectors**

1. All clamps, connectors and S.S. hardware shall be designed, manufactured and tested as per relevant standards.

2. All clamps & connectors for connection with ACSR conductors shall have high tensile aluminium alloy body. U-bolt/Hex head bolt and nut, plane washer, bevel washer for the clamp shall be made of non-magnetic material e.g. stainless steel.

3. Bolt, nut, washer, shackle etc. required for other purpose shall be of forged steel with adequate strength and the surface shall be so protected as to offer maximum resistance to corrosion. Malleable iron wherever used for any part shall be of best quality and shall correspond to latest amendments of relevant IS.

4. Various fittings & accessories of the clamps & connectors shall be so designed as to eliminate sharp edges & maintain bright smooth surface. All bolts, nuts, rivets etc. shall have round profiles.

5.18.11 **Disc Insulator**

1. All disc insulators shall be dimensioned appropriately so as to have the required electro - mechanical strength for EHV outdoor duties.

2. Suspension and tension string assembles shall be supplied as per details given in Specification. All Insulators and fittings shall generally be supplied as per relevant IS amended to date.

3. Insulator shall be wet-process porcelain, brown glazed and free from all blemishes. Metal parts and hardware shall be hot-dip galvanised.

4. When operated at maximum system voltage there shall be no electrical discharge. Shielding rings, as necessary, shall be provided.

5. Insulation shall be coordinated with basic impulse level of the system. The creepage distance shall correspond to very heavily polluted atmosphere (31mm/kV).

6. For disc insulator 120KN of 11KV class shall be considered for 765KV & 400KV switchyard.

5.18.12 **Post Insulator Stack**

1. Post insulator stack shall be used to support the tubular aluminium bus or ACSR conductor of outdoor EHV switchyard. Height of the stack shall be adequate in order to maintain proper clearance of live conductor from ground surface. Post insulator shall be solid core type.

2. Each post insulator will be mounted on pipe steel structure. Post insulator shall be complete with necessary fixing clamp at top for clamping of tubular aluminium bus/ACSR conductor, as required. The insulators shall be provided with necessary nuts, bolts and washers.

3. Creepage distance shall be 31mm/KV

5.18.13 **Galvanized Steel Shield Wire**

1. Galvanized steel shield wire shall conform to the relevant IEC, BS or IS. The steel strands shall be drawn from high carbon steel rods produced by either acid or basic open-hearth process, the electric furnace process or basic oxygen process. The wire shall be hot dip galvanised.

2. Zinc used for galvanizing shall be electrotype high-grade zinc of 99.5% purity and shall conform to IS: 209 - 1966 or equivalent BS specification. The hot dip galvanizing shall be done as per IS: 4826 - 1968 for heavy coating.

3. There shall be no joint of any kind in the finished strand wire entering into the construction of earth wire.

4. The wire shall be 7/9SWG galvanised steel wire. The ultimate strength of individual strand shall not be less than 1000Kgs and that of complete wire shall not be less than 6972Kgs.

5.18.14 **Bundle Spacers**

1. Bundle spacers shall have enough strength so as to restore normal spacing of conductors after displacement by winds, short circuits etc. without damage or permanent deformation. The spacers shall have long life without fatigue or wear and shall have gentle but firm grip on conductor. They shall be able to withstand all the electromagnetic and electrostatic forces under different operating conditions including dead short circuit.

2. They shall be of one piece construction and shall not have separate small components.

3. The materials used in spacers shall be corrosion resistant and made of aluminium alloy of an approved type. All type of nut/bolt/washers shall be made from stainless steel.

4. The spacers shall be flexible enough so as to avoid distortion or damage to the conductor or themselves. Rigid spacers are not acceptable.

5.18.15 **Corona Control Rings**

1. Corona control rings shall be provided in 765KV & 400kV system with all string hardware fittings and shall be of such design and shape that they will reduce the voltage across insulator units adjacent to the conductor for each insulator string to a value which will prevent visual corona forming on metal parts of insulator and shall minimize radio interference voltage on the complete insulator string assemblies.

2. Corona control rings shall be made of high strength heat-treated aluminium alloy tube with a minimum wall thickness of 2.5mm.

5.18.16 **OPGW Cabling and Associated Hardware & Fittings**

1. Scope shall also include supply, laying and termination of single / multi-mode fibre optic cable (no. of cores shall be decided during detailed engineering) for both ends of 765KV & 400kV outgoing transmission lines including supply of termination equipment, distribution panel, junction boxes, splicing of fibre optic cable at both ends and supply of necessary multiplexers and converters, industrial grade ethernet switches, etc. Further the scope shall include all equipment / components / tools / spares required to make a complete, reliable and trouble free functional system, even if not specifically listed in this specification. The scope also includes special training of owner's testing, operation and maintenance staff.

2. All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the bidder during detailed engineering.

3. **Optical Fibre Characteristics**

a) **Attenuation**

The attenuation coefficient for wavelengths between 1525nm and 1575nm shall not exceed the attenuation coefficient at 1550nm by more than 0.05dB/km. The attenuation coefficient between 1285nm and 1330nm shall not exceed the attenuation coefficient at 1310nm by more than 0.05dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10dB.

The overall optical fibre path attenuation shall not be more than calculated below:

Maximum attenuation @ 1550nm: 0.21dB/km x total km + 0.05dB/ splice x no. of splices + 0.5dB/connector x no. of connectors.

Maximum attenuation @ 1310nm: 0.35dB/km x total km + 0.05dB/ splice x no. of splices + 0.5dB/connector x no. of connectors.

b) **Fibre Optic Cable Construction**

Overhead fibre optic cables shall be OPGW (Optical Ground Wire). The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service.

c) **Optical Fibre Cable Link Lengths**

The Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during detail engineering.

For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. and no additional payment shall be payable in this regard. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

d) **Optical Fibre Identification**

Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme.

Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres is included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the bidder.

e) **Buffer Tube**

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel.

f) **Optical Fibre Strain & Sag-tension Chart**

The fibre optic cable shall be designed and installed such that the optical fibres experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep.

While preparing the sag-tension charts for the OPGW cable the following conditions shall be met:

- The max allowable tension (MAT) / max strain shall be less than or equal to the MWT / strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The max allowable tension shall also be less than or equal to 0.4 times the UTS.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at max allowable tension (MAT) is less than or equal to the cable strain margin.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted along with the bid under various conditions mentioned below:

- 53°C, no wind and no ice

- 32°C, no wind and no ice
- 0°C, no wind and no ice
- 32°C, full wind and no ice
- 32°C, 75% full wind and no ice
- 0°C, 2/3rd / 36% of full wind (IS 802:1977/1995)

The above cases shall be considered for the spans from 100 m to 600m or higher span length applicable for the line in the range of 50m spans. Max. vertical sag, max. tension and max. sag at 0°C & no wind shall be considered for in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines. The bidder shall submit the stringing chart for review.

g) **Cable Materials**

The materials used for optical fibre cable construction, shall meet the following requirements:

h) **Filling Material**

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-F-5.

The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, non-hygroscopic, electrically non-conductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

i) **Metallic Members**

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

j) **Marking, Packaging and Shipping**

Drum markings: Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the purchaser's destination address, cable part number and specification

as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.

Cable Drums: All optical fibre cabling shall be supplied on strong drums provided with lagging of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

The spare cable shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on each drum shall be determined by a "schedule" prepared by the Contractor.

k) **OPGW Cable Installation Requirements**

The OPGW cable shall be installed on transmission lines under live line conditions, i.e. with all the circuits of the transmission line charged to their rated voltage

l) **Optical Ground Wire (OPGW)**

OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length.

The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/aluminium alloy / stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. Each buffer tube shall have maximum 12 no. of fibres. All fibres in single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

m) **Central Fibre Optic Unit**

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central

fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium – clad-steel wire strands are not allowed. Central fibre optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

n) **Basic Construction**

The cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the Owner and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors.

The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

o) **Breaking Strength**

The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

p) **Operating Conditions**

Since OPGW shall be located at the top of the EHV transmission line support structure, it will be subjected to aeolian vibration, galloping and lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors.

q) **Installation**

OPGW installed under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for live line working and fibre optic cable handling. The stringing procedure shall be submitted by the Contractor prior to stringing for Owner's approval.

The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on Owner specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

r) **Installation Hardware**

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, earthing clamps, down lead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The bidder shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of IEC 61284. The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as slip strength etc. shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of preformed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

Vibration Dampers: Vibration dampers having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7m/s shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis.

s) **Fibre Optic Splice Enclosures (Joint Box)**

All splices shall be encased in fibre optic splice enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. No more than 6 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalised after survey. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

t) **Optical Fibre Splices**

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

All fibre splices shall be accomplished through fusion splicing.

Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

All splices and bare fibre shall be neatly installed in covered splice trays. No more than six (6) fibres shall be installed in each splice tray.

For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.

For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

u) **Fibre Optic Approach Cables**

For purposes of this specification, a fibre optic approach cable is defined as the armoured underground fibre optic cable required to connect overhead fibre optic cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the fibre optic distribution panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the appendices. However, the bidder shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the bidder during the project execution and the contract price shall be adjusted accordingly.

Basic Construction - The cable shall be suitable for direct burial, laying in trenches & PVC/hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

Jacket Construction & Material - The approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

Optical, Electrical and Mechanical Requirements - Approach cable shall contain fibres with identical optical / physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile

strength member(s), fibre support / bedding structure, core wrap / bedding, and an overall impervious jacket.

Installation of Approach Cable - The approach cable shall be laid in the HDPE pipe in all condition.

Suitable provisions shall be made by the bidder to ensure adequate safety earthing and insulated protection for the approach cable.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installation of approach cables shall be supplied and installed by the bidder.

v) **Optical Fibre Termination and Splicing**

Optical fibre terminations shall be installed in fibre optic distribution panels (FODP) designed to provide protection for fibre splicing of pre-connectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The bidder shall provide rack / wall mounted Fibre Optic Distribution Panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

w) **Fibre Optic Distribution Panel**

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in fibre optic distribution panels in a manner consistent with the following:

All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to pre-connectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.

- FODPs shall be suitable for use with each of the cable types provided as part of this contract.
- FODPs shall accommodate pass-through splicing and fibre terminations.
- FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement
- All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the bidder shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.
- Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

x) **Optical Fibre Connectors**

Optical fibres shall be connectorized with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported.

y) **Methodology for Installation and Termination**

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the Owner for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. All installation practices shall be field proven and ISO accredited.

The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

5.18.17 **Tariff Metering**

The net power generated by the proposed plant will be exported to PGCIL/OPTCL directly through 765kV/400kV lines. Similarly, commissioning / start up power will be imported from 400 kV.

For metering export/import of power, one main meter and one check meter will be provided at suitable locations. Each of the main and check meters shall have the following features:

1. Microprocessor based
2. Measurement of import / export active energy, reactive energy and apparent
3. Energy. It shall also measure voltage, current, power factor, kW, kVAR, kVA etc.
4. Accuracy of 0.2S
5. Facility for downloading the data

In addition to Tariff metering system, suitable energy meters of 0.2s class shall be provided at generator terminals to record generated gross energy. This meter shall also used for calculation of auxiliary power consumption.

Tariff metering and associated CTs & PTs shall comply with the requirements of CEA regulations on installation and operation of energy meters and shall also comply with the requirements of grid authorities.

5.18.18 **Fault Disturbance Recorder (for 765KV & 400KV)**

1. One (1) number microprocessor based fault disturbance recorder which is designed to analyze the disturbance due to faults in the switchyard shall be provided for the plant. The equipment shall be complete with disturbance recorder, printer unit, control / display unit, junction box and accessories like auxiliary CTs and shunts. As an option Bidder shall offer fault recorder for each bay and all recorders shall be interlocked in such a manner that each one will be started simultaneously with one common VDU & plotter / printer unit, No. of fault recorder selected shall be such that at least 20% channels are available as spare. All fault recorders shall be mounted on one panel.

2. Provision shall be made to synchronize the electronic clock of each disturbance recorder with external master clock. Also, a number of disturbance recorders in the particular location shall be capable of being synchronized with any one of the recorders as master.

3. The microprocessor based fault recorder shall be designed to continuously monitor analogue, digital signals and contacts of all protective / lockout relays. Recording shall be self-started or triggered by di/dt, dv/dt, or change of state of any of the digital input signals. The data acquisition unit of the fault recorder shall be provided with self-test diagnostic feature which annunciates and alters the operator to rectify the defect or fault, if any.

4. The number of channels / recorders offered shall cover the following:

   - **Analog channels**: (a) Currents in 3 phases and neutral of all bays (b) voltages of 3 phases and their vector sum of all bays wherever VTs are provided.

   - **Digital channels**: Protective relay contacts lock out relay contacts. The total number of channels offered shall be such that 20% spare channels are available.

   - The fault recorder and all its peripherals shall be designed for operation on 220V DC. Recorders shall be provided with pre-history recording feature with pre-history recording time not less than 0.5 or 1sec.

5. Auxiliary CTs while catering for the required VA burdens hall not saturate under maximum fault current conditions. Auxiliary multi ratio PTs shall be provided to facilitate tap selection in voltage signal recording. The accuracy of analog channel recording shall be less than +3% for current channels and +1% for voltage channels.

5.18.19 **Sequence Of Events Recording System (SER)**

1. The SER system shall be an independent microprocessor based system and shall be a part of station DDCMIS system or part of SCADA system.

2. SER shall be designed for digital inputs from each phase of 6 line breakers, each of generator and station transformer breakers, isolators, earth switches, each protection and alarm relay (for each phase wherever applicable) position of stay put control switch position, close and open commands from each breaker and isolator control switch etc. The chronological print-out facility shall be provided for any of the first 100 occurrences. Further occurrences shall be printed chronologically. This list is only indicative and not exhaustive.

3. The event recorder shall be suitable for operation on 220V DC supply.

5.18.20 **On Line Partial Discharge (PD) Monitoring System**

For 765KV & 400kV GIS Partial Discharge Measurement is mandatory. As such on line partial discharge (PD) monitoring system as per IEC60270 shall be envisaged for continuous monitoring. The number and location of these sensors shall be based on the laboratory test on typical design of GIS as per IEC recommendation of CIGRE Document No 654. (Application for sensitivity verification for PD detection system for GIS).

6.00.00 TESTING AND INSPECTION

6.01.00 **General**

6.01.01 All equipment, apparatus, materials and supplies provided under this Contract shall be subject to tests in the shop in the presence of the Owner/consultant and in the field, for ensuring conformity to the requirements of the specifications. The method and procedure of the tests shall be submitted.

6.01.02 Manufacturer shall, at his own expense, promptly make good all defects evident by testing or made apparent in any other way. After defects in the plant have been remedied, the plant will be subjected to such retesting as may be necessary until the plant is proved to be in satisfactory operation.

6.01.03 Within 30 days of completion of each and every test required as proof of compliance with the specifications and/or each and every specified test, including commissioning tests, manufacturer shall submit to the Owner six (6) signed copies of a report covering such tests.

6.01.04 Test reports shall indicate the tests performed, the results obtained, instruments used, names of test personnel and provisions for witnesses signatures. They shall also be numbered and dated. Format of these reports shall be submitted at the same time as the test procedures specified above.

6.02.00. 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 electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions.

The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. 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 for owner approval..

PACKING, STORAGE AND UNPACKING

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.

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.

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.

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.

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. The type of gas, the maximum pressure to which sections will be filled prior to shipment and the minimum allowable pressure during shipment shall be advised prior to dispatch.

All 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 owner . 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 serial 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.

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 . The raised platform for temporary storage shall be made ready before arrival of the GIS equipment at site.

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.

The contractor will be able to use the available storage areas at site. 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 off the ground, as required etc. is included in the works to be performed by the contractor.

The equipment shall only be unpacked or removed from the containers immediately prior to being installed. 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/air or SF6 gas until required.

INSTALLATION OF GIS

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

The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall supervise critical & important erection works. The help of local technicians can be taken only for material handling and non-critical erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate to OWNER.

Un-packing of GIS modules shall be done outside the GIS hall and in no case module to be taken inside GIS hall with packing. All drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of work.

Proper power supply shall be ensured by contractor prior to commencement of erection work so that assembly work is not interrupted in the middle which is critical for GIS installation.

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.

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.

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 at regular interval throughout the day with separate team of persons assigned for cleaning work only.
Only T&P and consumables required for GIS erection shall be kept in GIS during erection.

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 etc)

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

A separate room shall be identified in consultation with OWNER for carrying out repair works/ small part assembly and the room shall be weather protected and lockable. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in the separate room for rework.

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

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 OWNER site before start of erection. Method statement shall include record of shock/ impact recorder at the time of unpacking. Shock recorder down loaded data and analysis shall be submitted before commencement of erection work. In case of violation of shock limits, expert form manufacturer shall visit and do the 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.

Cleaning is of utmost importance and hence before assembly, all the loose metal parts, subassemblies and all contact & sealing surfaces shall be cleaned before installation. Cleaning shall be carried out with specified cleaning agents of the manufacturer in no condition water is to be used except for external surfaces. Further, prior to opening, gas compartment shall be thoroughly cleaned and vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected. Dust disturbance in the area to be avoided. Also, before closing a flange connection clean the immediate vicinity and all accessible parts of the components shall be connected with a vacuum cleaner.

Once the transport covers are removed installation of flanges shall be done without any interruptions, if interruptions cannot be avoided open flanges are to be covered with clean plastic foil. Transport covers, O-rings and other packing material shall be taken out of GIS after immediately after removal.

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.

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

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

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

6.02.00 **Factory Tests**

6.02.01 **Type Tests**

a) Evidence shall be given that the proposed switchgear components to be supplied under this contract have been subjected to all type tests at an internationally recognized testing station, and to be approved / recognized by Owner If it deemed necessary, Owner will decide whether additional tests are necessary to be performed.

b) The bidder shall submit type test certificates covering the proposed switchgear components.

c) Type tests certificates/reports shall be considered acceptable if they are in compliance with the latest applicable relevant Standards (class "A" as per IEC Standards) and the following:-

- Type Tests conducted at an internationally recognized laboratory (KEMA or equivalent) acceptable to Owner.
- Repeated type tests conducted at the manufacturer's laboratory, witnessed by representatives from an internationally recognized laboratory (KEMA or equivalent) and accepted by owner.

d) For the offered circuit breaker type, type tests results of already executed tests shall be indicated in the concerned technical data sheet.

e) If the presented type test results are not in accordance with the above requirements, Owner reserves the right to ask for the type tests to be repeated in the manufacturer's premises or other places subject to the approval of Owner and at no additional cost. These tests shall be performed by an internationally recognized laboratory (KEMA or equivalent) and in the presence of Owner. The internationally recognized laboratory shall issue the relevant type test certificates upon successful test.

f) Valid type test report as per IEC 62271-203 shall be submitted including following tests

- Dielectric tests
- Temperature rise test
- Internal arc test
- Making and breaking tests
- Rated peak withstand current and rated short time current tests on main and earthing circuits
- Operation & mechanical endurance tests.

6.02.02 **Routine Tests**

In case of non- availability of valid Type test certificates, these type tests are to be carried out

a) Switchgears and their components shall be subjected to routine tests as per the latest relevant IEC recommendations.

b) Routine test certificates shall be submitted for Owner's review and approval before shipment of the switchgear components.

c) Following tests shall be performed as routine tests in addition to the standard tests:

- At least one local control cubicle (LCC) shall be tested together with the GIS during factory acceptance tests
- Speed and timing tests for circuit breakers
- Partial discharge measurements
- Chattering time of the arc contact shall be measured and recorded at no-load operations
- Visual inspection of the switchgear, in order to ensure that all components are mechanically assembled and fixed properly and that there are no imperfections.

6.03.00 **Site Tests**

6.03.01 For site tests, the following shall be performed in particular:-

a) Speed and timing tests for circuit breakers

b) Timing tests for disconnectors and earthing switches

c) Humidity/dew point measurement tests of SF6 gas during commissioning, three months after that, before issuance of FAC, and at each refill operation. Critical dew points are subject to the approval of Owner.

d) Voltage drop tests during commissioning

e) Functional interlocking tests

f) Power frequency voltage test for switchgear and auxiliary circuits. The power frequency test (50Hz) voltage shall be 65% of the rated voltage for existing busbar extensions and 80% of rated voltage for new GIS.

g) Gas leakage test on each bay with high sensitive gas leakage detector on all seals.

h) Partial discharge measurement for 400kV is mandatory.

6.04.00 The Bidder shall prove that the HV circuit breakers are capable of interrupting

a) The capacitive current, and

b) The inductive current

6.16.00 for switching of capacitors/shunt reactors under site conditions, both by either performing the relevant tests or by submitting the relevant type test reports plus calculations, to the satisfaction of Owner

6.06.00 The Bidder shall furthermore advise and guarantee the minimum number of switching operations for the conditions as mentioned above within the arrangement as designed by him.

7.00.00 DRAWINGS, DATA, INFORMATION AND MANUALS

7.01.00 Drawings, data, information and manuals shall be submitted as indicated below:-

7.02.00 **Along with the bid**

a) Electrical single line diagram showing metering, protection scheme & a write-up on control philosophy.

b) Type of plant & equipment proposed to be used.

c) Write-ups, curves and information required to fully describe the equipment & system offered

d) List of different equipment and make.

e) Technical leaflets and general constructional details.

f) Type test report of similar equipment.

g) Auxiliary power supply arrangement.

h) BOQ of major Equipment

i) Bidder to submit the performance certificate for major items supplied / manufactured by them like CT, CB, CVT, PT, Isolator, C&R panel for satisfactory operation of at least three years as on date of bid opening and shall ensure that offered major items shall be supplied by them only from same manufacturing unit / works against which they will submit the above performance certificate.

7.03.00 **After the award of contract, the following drawings shall be submitted progressively:-**

a) Complete Bill of Materials.

b) Single line diagram giving rating of each equipment

c) Gas Schematic Diagram

d) Guaranteed Technical Particulars of GIS

e) 3d General arrangement drawing to show the location of equipment to access it

f) Interface module drawing for GIS Extension

g) Design calculations in support of selection of equipment rating and system design.

h) Layout of substations with sections

i) Technical particulars of each equipment and accessories

j) Grounding & lightning protection drawings and details

k) Cabling, cable trench, tray layout and culverts with section & details

l) Dimensional general arrangement drawing along with cross-sections for equipment

m) Erection Key Diagram for GIS and AIS.

n) Clearance check diagram for AIS.

o) Seismic Analysis report for GIS.

p) Rating & Nameplate Drawing

q) Block Logic Diagram

r) Quality Assurance Plan of major Equipment

s) Test Certificates of major Equipment

t) Foundation plan and loading data.

u) Fire Fighting and sump pump arrangement

v) GIS/LCC Control schematic and wiring diagram

w) Cable schedule and interconnection

x) Relay Setting and co-ordination
Insulation coordination study report, Very fast transient over voltages (VFTO) Report

y) Pre- Commissioning & commissioning checklist.

z) GIS Platform and walkway drawing

aa) Civil and structural analysis, design calculations and working drawings including bar bending schedule and fabrication.

bb) Erection/Installation Manual , Operation & maintenance manual

cc) Any other drawings & data as required for satisfactory installation, operation & maintenance.

ANNEXURE-A

SYSTEM PARAMETERS

1.	Voltage (Nom. / Max.). KV	33/36	400/420	765/800
2.	Frequency	50±5%	50±5%	50±5%
3.	Fault Level	31.5kA rms	63kA rms	50kA rms
4.	System earthing	Solidly earthed	Solidly earthed	Solidly earthed
5.	Short-time current rating (for all current carrying parts)	31.5KA for 1second	63KA for 1second	50KA for 1second
6.	Basic Insulation Level KV_{PEAK}	170	1425	2100
7.	Switching Impulse KV_{PEAK}			
a)	Between line terminal & ground		1050	1550
8.	Power frequency withstand voltage KVrms Dry/Wet	70	630	830/870
9.	Maximum radio interference voltage for frequency between 0.5 to 2MHz in open & close condition (Micro volt)	NA	1000 (at 320kV rms)	2500 (at 508kV rms)
10.	Rated Normal Current busbar	1250A	3150A	3150A
11.	Rated Normal Current feeder	630A	1250A	1250 A
12.	Rated short breaking current	31.5kA	63kA	50kA
13.	Rated peak withstand current	78.75kA	157.5KA	125KA
14.	Rated Short-time withstand current	31.5kA	63kA	50KA
15.	Leakage rate per year and gas compartment-%	<=0.5	<=0.5	<=0.5
16.	Driving mechanism of circuit-breaker	Stored energy spring	Stored energy spring / Hydraulic	Stored energy spring / Hydraulic
17.	Operating Sequence	0-0.3s-CO-3 min-CO	0-0.3s-CO-3 min-CO	0-0.3s-CO-3 min-CO
18.	Minimum clearances in air			
a)	Phase to Phase, mm	320	4200	9400
b)	Phase to Earth, mm	320	3500	6400
19.	Safety Clearances			
a)	Safety working clearances, mm	3000	6500	10300
20.	Creepage distance mm for SF6 to air bushing		Bidder to furnish	
21.	Auxiliary Power Supply			
a)	A.C. System	415V / 240V	415V / 240V	415V / 240V
b)	D.C. System	220V	220V	220V
c)	UPS (if required)	240V	240V	240V

Maximum radio interference voltage for frequency between 0.5 to 2MHz in open & close condition (Micro volt)-as per IEC 62271-1, Cl.7.9.1

ANNEXURE-B

RATINGS AND REQUIREMENT

1.	The ratings and electrical characteristics of the complete GIS shall be as given hereunder. The ratings applicable to specific items of equipment are included in the relevant clauses dealing with that equipment	
2.	Type of GIS	Single phase enclosed switchgear for 765kV & 400kV and three phase for 33kV
3.	Location	Indoor
4.	Maximum ambient temperature	50°C
5.	Minimum ambient temperature	5°C
6.	Nominal voltage class, kV rms	765KV 400KV 33KV
7.	Rated voltage, kV	800KV 420 KV 36KV
8.	Rated frequency, Hz	50
9.	Number of phases	Three
10.	Number of busbars	Two (for 765kV and 400kV) / One (for 33kV)
11.	Rated normal current at 50Hz, A, rms	3150A 3150A 1250A
12.	Rated short circuit current at rated maximum voltage, not less than, kArms (symmetrical)	50KA 63 KA 31.5kA
13.	Lightning impulse withstand voltage (phase to phase and phase to earth) at minimum operating gas pressure	2100 1425 170
14.	Switching impulse withstand voltage (Ph – E)	1550 1050 -
15.	1 minute power frequency withstand voltage, kVrms	830 630 70
16.	Rated peak withstand current, kA crest system	125 157.5 78.75
17.	Material of enclosure	Aluminium Alloy
18.	Material of busbar	Copper / Aluminium Alloy
19.	Insulation medium	SF6
20.	Leakage rate of SF6 per annum for each compartment	Less than 0.5%
21.	Partial discharge level, pc	Less than 10 at 1.5 Un/ 3
22.	Noise level	48 dB
23.	Degree of protection	IP55
24.	Max. SF6 operating pressure	< = 8.5
25.	Rated auxiliary supply voltage	220V D.C. / 415V, 3 phase / 240V single phase
26.	All current carrying components of the equipment specified shall be capable of continuous operation at the specified rated current without exceeding the maximum temperature rises specified in the relevant IEC standards.	
27.	Thermal calculations shall be based on the climatic conditions given above.	
28.	33KV GIS shall comply to IEC 62271	

ANNEXURE-C

HIGH VOLTAGE OUTDOOR BUSHING (PORCELAIN TYPE)

1.	Applicable standards	IEC 60137, 61463	IEC 60137, 61463	IEC 60137, 61463
2.	Operating voltage (U0/U)	33KV	400kV	765KV
3.	Highest System voltage	36KV	420kV	800KV
4.	Rated short-circuit withstand current	31.5kA/1 sec	63kA/1sec	50kA/1sec
5.	Rated peak withstand current	78.75kA	157.5kA	125kA
6.	Insulation medium	SF6	SF6	SF6
7.	Material of enclosures	Porcelain	Porcelain	Porcelain
8.	Lightning impulse withstand voltage (peak) (phase to phase and phase to earth) at minimum pertaining gas pressure	170kV	1425kV	2100kV
9.	Switching impulse withstand voltage (phase to earth) at minimum gas pressure		1050kV	1550kV
10	Power frequency withstand voltage (1 min.) (phase to phase and phase to earth) at minimum operating gas pressure Rated current	70kV	630kV	830kV

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SECTION-IX

MANDATORY SPARE, TOOLS & TACKLES

1.00.00 SCOPE

This section covers the general requirements regarding the mandatory spares and tools & tackles for all the equipment and systems used for three (3) units, each of 800 MW, coal based NLC Talabira Thermal Power Station, for NLC India Limited (NLCIL) at Jharsuguda, Odisha.

2.00.00 MANDATORY SPARES

The Bidder shall supply in his scope mandatory spares as specified in this Section. The price of each item of mandatory spares shall be indicated in the offer.

The supply of mandatory spares shall be started with the last consignments of the first unit and completed before the provisional takeover of the first unit.

3.00.00 TOOLS & TACKLE

The Bidder shall supply with the equipment one complete set of tools and tackle as required for the operation & maintenance of the equipment. These tools will also include special material handling equipment, jigs & fixtures for maintenance and calibration/readjustment, checking & measurement aids etc. The list of tools & tackles to be supplied by the Bidder for Mechanical, Electrical & C&I items is attached with this specification. The price of each tools/tackles shall be indicated in the offer. These tools & tackles shall be separately packed and sent to site before the provisional takeover of first unit. The Bidder shall also ensure that these tools are not used for erection purpose.

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The supply of tools and tackles shall be started with the last consignment of first unit.

4.00.00 GUIDELINES FOR MANDATORY SPARES AND TOOLS & TACKLE

The Bidder shall supply the mandatory spares and tools and tackles as listed.

a). The Bidder shall give itemized unit price for the spare parts, tools and tackles while submitting the Bid. The Owner reserves the right to modify or delete the items/quantity of the spares/tools & tackles. The quoted price for taxes & duties, transport, insurance etc. shall get reduced proportionately to the extent of the value of ordered spares/tools and tackles. The list of such spares/tools and tackles to be ordered by the Owner shall be finalized by the Owner before signing of the Contract.

b). In case the description / nomenclature of any of the items of spares/tools and tackles is differing from the description / nomenclature indicated in the list of mandatory spares/tools and tackles, the Bidder shall offer functionally equivalent part in lieu of the listed item (with their nomenclature).

c). In case if such items of spares/tools & tackles indicated as "not applicable", are found applicable at a later date during execution of the project, such items of spares/tools & tackles are to be supplied within the ordered cost of the mandatory spares.

d). If any of the items of spares/tools & tackles ordered is found to be not applicable during detailed engineering stage/execution stage, the Bidder shall have to supply alternative items of spares/tools & tackles. The alternative items of spares/tools & tackles are to be mutually agreed between the Owner and Bidder.

e). In respect of quantity mentioned as 'Set' means the total quantity of all the components/items used in particular equipment unless otherwise specified.

Example-1

One set of spare part which is having four different items of which first item is having 2 similar parts, second one is having 3 similar parts and other two are having one part each, then one set means, combination of 2 similar parts of first item and 3 similar parts of second and one each of 3rd & 4th items.

Example-2

If the quantity of particular spare part is more than one, set means the total no. of similar parts.

f). Wherever % is indicated for the mandatory spares, the quantity shall be calculated for % of supply for total quantity for 3 units of 3x800 MW, unless otherwise specified. Any fraction so arising after calculating the percentage, shall be considered as next whole number.(e.g. If the percentage comes as 2.1 or 2.9, then 3 nos..of item shall be provided)

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g) All relevant drawings & schedules to identify spares/tools & tackles are to be furnished when called for by the Owner.

h) Spare parts for equipment shall be of the same make and be interchangeable with the original components.

i) Wherever % is indicated for the mandatory spares, If the quantity of the main population of any item is only one no., then the spare quantity shall also be one no.

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SCHEDULE OF WEIGHTS & DIMENSIONS

The Bidder shall state, hereunder, the weights & dimensions of various packages, for shipment, comprising the complete scope of supply:

Sl.No	Package Description	Dimensions, L x B x H (metres)	Weight (Tonnes)

Signature :
Name :
Designation :
Company :

Company Seal

Date :

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT (TALABIRA PROJECT SITE)

The various site specific seismic parameters for the project site shall be as follows:

1)	Peak ground horizontal acceleration (MCE)	: 0.14g
2)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra	
a)	for Special moment resisting steel frames designed and detailed as per IS:800	: 0.048g
b)	for special concentrically braced steel frames designed and detailed as per IS:800	: 0.036g
c)	for special moment resisting RC frames designed and detailed as per IS:456 and IS:13920	: 0.048g
d)	for ordinary moment resisting RC frame designed and detailed as per IS:456 and IS:13920	: 0.145
e)	for critical power plant structures like boiler structure	: 0.096
f)	for RCC chimney	: 0.096g
g)	for RCC cooling tower	: 0.04g
h)	for RCC liquid retaining tanks	: 0.04g 0.04gg
i)	for steel chimney, Absorber tower, Vessels	: 0.096g
j)	for design of structures not covered under 2(a) to 2(f) above and under 3 below, in general (excluding special structure/configuration/materials)	: 0.048g
3)	Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted	: 0.096g

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SECTION-III

PROJECT SYNOPSIS AND GENERAL INFORMATION

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SECTION-III

PROJECT SYNOPSIS AND GENERAL INFORMATION

1.00.00 INTRODUCTION

NLC India Ltd. (NLCIL) formerly Neyveli Lignite Corporation Limited is a 'Navratna', Government of India Enterprise engaged in mining of lignite and generation of power through lignite based thermal power plants. NLCIL was established by Government of India in 1956, following the discovery of lignite deposits in Neyveli, Tamil Nadu. NLCIL currently operates four open cast lignite mines in Neyveli (Tamil Nadu) and Barsingsar (Rajasthan) of total capacity of 30.6 Million Tonnes per Annum (MTPA). The company operates five pithead thermal power stations at the above locations with a total installed capacity of 3640 MW. NLCIL, through its subsidiary NTPL, has also recently commissioned a 1000 MW coal based power plant at Tuticorin (Tamil Nadu), 1001.56 MW solar plants and 51 MW wind power plant at Kazhuneerkulam (Tamil Nadu), thus bringing the total installed capacity of the company to 5581.56 MW**.**

In addition, another 3X660 MW coal based thermal power project at Ghatampur, U.P. in joint venture with U.P. is under execution

NLCIL have now taken up implementation of Coal based pit head type NLC Talabira Thermal Power Project, consisting of three (3) supercritical units of 800 MW capacity each, near Kumbhari & Tareikela villages in Jharsuguda District, Odisha. Development Consultants Private Limited (DCPL) has been appointed as the Consultant for the project.

2.00.00 LOCATION

The plant and township of the project proposed to be located near Kumbhari and Tareikela villages on south west of Brijraj Nagar town on Sambalpur Rourkela highway in Jharsuguda district and ash disposal area is located near Thelkolai village in Sambalpur district. The main plant area is defined by the following coordinates:

Description	Latitude	Longitude
North Extreme	21° 46’ 56.11’’ N	83° 59’ 30.59’’ E
East Extreme	21° 46’ 52.95’’ N	84° 00’ 20.72’’ E
South Extreme	21° 45’ 16.80’’ N	83° 59’ 9.36’’ E
West Extreme	21° 46’ 34.18’’ N	83° 58’ 50.54’’ E

3.00.00 ACCESS

The project site is approachable from Sambalpur – Jharsuguda highway after crossing Bedhan River via state PWD road. Two separate 4 lane roads from Sambalpur – Jharsuguda highway have been envisaged for main approach to the project site. The nearest airports are at Bhubaneswar at a distance of 350 km and Raipur airport is at a distance of approx. 290 km. Nearest railway station at Jharsuguda on Howrah- Nagpur main (trunk) section is at a distance of 11 kms.

4.00.00 WATER

The consumptive water is proposed to be drawn from Hirakud reservoir at a location downstream of Rambella bridge, at a distance of about 22 km and shall be pumped to the in-plant raw water reservoir. In-principle approval of State Government is available. The intake pump house location is proposed at Khata No. 01 (5.34 Acres) of Jogipalli Village. However, water drawl point location, pipe routing and other details need to be finalized in consultation with WRD,GOO.

Total consumptive water requirement for the Project (3x800 MW units) is estimated as 6700 cu-m/hr. with ETP recovery and COC 5.

The chemical analysis of raw water to be used in the Plant is attached in Section-XV of this Volume II-A**.**

5.00.00 FUEL

The primary fuel for this plant is Coal.

Coal requirement of the project shall be met from Talabira -II & III captive mines of NLC India Limited located nearby. Coal requirement is estimated to be 11.37 MTPA considering a GCV of 3700 Kcal/kg, and PLF of 85%. The coal shall be transported from the linked mines through Belt Conveyor system from coal stock at mine end up to transfer point and thereafter by Pipe conveyor for crossing Bedhan River up to crusher house located in plant area..

The characteristics of Coal to be used in the Plant are attached in Section-XV of this Volume II-A.

LDO/HSD shall be used as start-up fuel and flame stabilizing fuel.

Fuel oil (LDO/HSD) will be transported by road tankers from the nearest oil depot.

The properties of Fuel oil (LDO/HSD) to be used in the Plant are attached in Section-XV of this Volume II-A.

6.00.00 POWER EVACUATION

The power generated from the project will be evacuated through adequate no.of 765 kV& 400kV Transmission Lines Two (2) nos. of (765/√3) / (400/√3) / 33 kV Interconnecting Transformer shall be provided between 765kV& 400kV GIS. Unit start-up power requirement shall be met by back charging 765 kV GIS and 400 kV GIS through ICTs. Unit start-up power requirement will be drawn from 400 kV bus through 400/11.5/11.5 kV Station Transformer

7.00.00 IMPLEMENTATION SCHEDULE

The Project is planned to be executed through single EPC Contract. The scheduled key milestones of the Project (late finish), counted from the date of issue of LOA to the EPC Bidder for single EPC Package are as follows

a) Completion of Trial operation of Unit no. I : 52th Month from LOA

b) Completion of Trial operation of Unit no. II : 58th Month from LOA

c) Completion of Trial operation of Unit no. III : 64th Month from LOA

8.00.00 METEOROLOGICAL DATA

The meteorological station nearest from the site is Jharsuguda. Salient meteorological data of site is given below:

a)	Mean Ambient temperature	:	33.1 ºC maximum 20.7 ºC minimum 27.5 ºC average
b)	Extreme Ambient temperature	:	48.0 ºC maximum 6.0 ºC minimum
c)	Mean wet bulb temp	:	26.3 ºC
d)	Mean relative humidity	:	
	(I) At 8.30 hrs.		66%
	(ii) At 17.30 hrs.		50%
e)	Annual Rainfall	:	1445 mm
f)	Wind load	:	In accordance with IS-875 for a basic wind speed of 50 m/sec, up to a height of 10 meters above mean ground level.
g)	Seismic Zone	:	Zone III as per IS:1893 latest edition.
h)	Altitude	:	203 M above MSL

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SECTION-V

GENERAL TECHNICAL REQUIREMENTS

1.00.00 CODES AND STANDARDS

1.01.00 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.

1.02.00 The Bidder shall submit along with his bid the list of main codes and standards proposed to be used for the design, construction and testing of the plant. Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Electricity Rules, Indian Explosives Act, Factories Act etc. Wherever required, approval for the Plant supplied under the specification from statutory authorities shall be the responsibility of the Successful Bidder.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern. And if they are equally stringent, the Bidder shall follow the hierarchy as follows:

i) Local regulations
ii) Local codes and standards
iii) This Technical Specifications
iv) Industry codes and standards

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Successful Bidder proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Successful Bidder to advise Owner of the resulting effect.

1.06.00 Combining or mixing of codes and standards of different institutions with respect to individual engineered components/ equipment shall not be permitted without the written approval of the Owner.

2.00.00 RESPONSIBILITY FOR DESIGN

2.01.00 The Bidder shall assume full responsibility for the design of the whole and every portion of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Successful Bidder was directly involved in the design work.

2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions as per the stipulation furnished elsewhere in the specification.

2.03.00 The Bidder shall carry out optimization studies for selection of pipe size and equipment wherever required. The result of such studies shall be included as part of bid proposal.

The successful Bidder shall have to carry out surge analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.

2.04.00 The Bid shall include a detailed discussion on the development status of and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the Bidder as reference plants.

3.00.00 DESIGN CRITERIA & OPERATIONAL REQUIREMENTS

3.01.00 Gross Capacity

The Steam Turbine Generator & Auxiliaries shall be capable of delivering Gross Capacity of not less than 800 MW on continuous basis, with rated steam parameters, design condenser pressure and 1% cycle make up .The Turbine shall be capable of running in VWO condition (105% of Gross capacity).The Boiler shall be capable of delivering 2475 T/Hr steam at rated parameter or 102% of VWO with 1% cycle make up ,whichever is higher. This output shall be guaranteed and demonstrated by the Bidder for STG & auxiliaries units, as described in GCC.

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3.02.00 Equipment Sizing Margins

The equipment sizing design margins shall be used, as specified in the relevant clauses of the Design Specification.

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3.03.00 Number of Starts

The expected number of unit start-ups during 25 years of design life should be considered as minimum (Based on duration of shut down)

Cold start-up (shutdown >72 hours) : 150 starts.

Warm start-up (10 - 72 hours shutdown) : 1000 starts.

Hot start-up (2 - 10 hours shutdown) : 4000 starts.

Start-ups and load cycles together the TG & auxiliaries unit should be designed for minimum of 5150 cycles.

Following definitions shall apply for Cold start, Warm start, Hot start and Very Hot Start:

(a) Cold Start: start after a continuous shut-down period exceeding 72 hours (metal temperatures below approximately 40 % of their fully-load values in ^{o}C).

(b) Warm Start: start after continuous shutdown period between 10 hours and 72 hours (metal temperatures between approximately 40 % and 80 % of their fully-load values in ^{o}C).

(c) Hot Start: start after continuous shutdown period less than 10 hours (metal temperatures above approximately 80 % of their fully-load values in ^{o}C).

3.04.00 Minimum Load

3.04.01 The Steam Generator unit will be able to operate continuously at 40% rated output load without oil support and with worst type of Coal under automatic control.

3.04.02 Mill Turndown ratio: minimum 3:1

3.05.00 House Load Operation

In the event of total load rejection and disconnection from the external network, the unit shall be able to operate safely at the `House Load' feeding only the unit auxiliary services for an expected period of more than one (1) hour. In this case of load rejection, Boiler firing rate shall be brought down to 60% BMCR by suitably cutting out the pulverisers.

3.06.00 Mode of Operation

Modified sliding pressure operation

a) 0 to 40% TMCR : Constant Pressure Operation

b) 40% TMCR to 100%TMCR : Modified Sliding Pressure Operation (with throttle margin which can cater 5% load variation).

c).100% TMCR to VWO : Constant Pressure Operation.

3.07.00 Load Change Rate and Temperature Variation

3.07.01 Load change

a)	Step load change	Minimum ± 10%
b)	Ramp Rate	Minimum ± 3% per minute above 30 % to 50% load
		Minimum ± 5% per minute (50% to 100% load)

3.07.02 Maximum temperature variations

a) Under steady state condition : ± 5°C for SH and RH

b) During Load change

i) 3% per minute : ± 10°C for SH

ii) 3% per minute : ±10°C for RH

3.08.00 Operating Capability:

1) The operating capability of various systems, equipment and associated auxiliaries in the scope of the Bidder is specified elsewhere in the Technical Specification.

2) The plant, it's unit (s) and its all auxiliaries equipment/systems shall be designed to operate with all the specified margins for continuous operation without any limitations under any of the conditions indicated in the Technical Specification.

The major operating capabilities for the unit(s)/plant shall be as follows:

a) Operate continuously with turbine under VWO condition with rated steam parameters, design condenser pressure and 1% cycle make up.

b) Sliding Pressure Operation from rated pressure down to 40% of rated pressure with as well as without any throttle reserve. For modified sliding pressure condition, at any operating load, the throttle reserve shall be sufficient so as to achieve an instantaneous increase in turbine output by 5% of the corresponding load, by opening turbine control valves wide open. However the output after instantaneous increase shall be limited to 105% of TMCR Load. The throttle reserve shall be 0% for pure sliding pressure mode of operation.

c) Operate continuously with HP heaters out of service with 89 mm Hg(a) condenser pressure.1% cycle make up and normal

auxiliary steam requirement being tapped from cold reheat line, to generate maximum output without over stressing turbine components. The power output of the unit under this operating condition shall not be less than 800 MW or output corresponding to design BMCR heat duty, whichever is lower.

d) In case of sudden reduction in demand (load throw off), the unit should get safely unloaded and stabilized for operation at house load with HP-LP bypass open to full capacity.

e) HP-LP bypass operation under rated steam conditions with bypass valve open to full capacity and turbine on house load.

f) Automatic run back capability of the unit load on loss of critical auxiliary equipment, ensuring smooth and stable runback of the Steam Generator and Steam Turbine Generator equipment and systems.

g) Continuous TG output of 800 MW under rated steam conditions, 89 mm Hg(a) condenser pressure, 1% cycle make-up and 47.5 Hz grid frequency.

h) The equipment and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz.

i) Unit shall be capable of increasing the load through condensate flow regulation in order to meet the load cycling requirement. Necessary measurements and logics shall be provided for implementation of the same. During condensate flow regulation condensate tank level may be maintained through excess condensate dump line to condensate storage tank.

3) All the systems/equipment/auxiliaries under Bidder's scope shall be designed to cater to the above operating conditions envisaged for the unit(s)/plant by the Owner. Unless specified otherwise in the Technical Specification the design should cater to the above operating conditions with adequate margin as per standard practice prevailing in the fossil fired power plants.

4) The plant shall be suitable for load cycling which implies that it should be designed to operate continuously under two shift mode (daily start stop with one shift off) and load follow mode as specified. The design would cover adequate provision for quick start-up and loading of the units to full load at a fast rate. The unit shall have minimum rate of loading or unloading of 5% per minute above the control load (i.e. 50% MCR). Plant shall be capable of minimum N1 number of daily load cycles (N1 shall not be less than 2) from load variation from 100% to 50 % (and vice versa) of MCR with a minimum ramp rate of 5% per minute without affecting the design life of boiler and turbine systems. In addition, the plant shall also be capable of minimum N2 number of

daily load cycles (N2 shall not be less than 1) from 50% MCR to boiler minimum once through load (and vice versa) with a minimum ramp rate of 3% per minute without affecting the design life of boiler and turbine systems. Bidder shall fill the values of N1 and N2 in the relevant Attachment of the bidding document and shall demonstrate the same during initial operation. The main plant and its auxiliaries with their controls would be designed to permit operation of the units on house load without there being any necessity to shut down the units in the event of sudden loss of total load due to tripping of transmission lines or any other grid disturbances. The design of the plant equipment and control system would permit participation of the plant in automatic load frequency control.

5) Bidder shall furnish, within 6 (six) months from the date of placement of award / during detail engineering, following details:

a) 'Fatigue Damage', resulting from

i) The number of Cold start up, Warm start up and Hot start up as defined elsewhere in the specification and

ii) Load cycling during defined plant life.

b) 'Creep damage'

c) Creep-Fatigue interaction curve for materials (selected for vulnerable locations) for which fatigue and creep damage have been computed along with the reference used for creep fatigue interaction curve.

d) The combined creep fatigue damage shall lie within acceptable limits.

e) Material data used for determining the fatigue and creep damage.

f) Code used for determining fatigue and creep along with details of its validation.

g) Details of specific changes in design to accommodate the defined load cycling.

h) For the steam generator, in addition to the above requirement, specific design features incorporated and design/process improvements which are being offered for N1/N2 cycles shall be submitted along with the bid. Such design features and design/process improvements over and above conventional design shall be clearly brought out by the bidder in its bid. The Bidder shall provide references for earlier supplied steam generators which meet the specified cyclic duty requirements.

The analysis and design/process improvements for cyclic operation suitability shall include all critical boiler components like headers (final Super heater outlet, economizer outlet, final reheater outlet etc.), membrane wall construction elements (tubing attachments, tension bars etc.), wind-box elements, boiler recirculation pump casing, superheater/reheater attachments, dissimilar weld joints etc. The

Bidder shall provide information to the process adopted and analysis carried out for the design and operational improvements. Following shall be necessarily included:

a) Header thickness reduction: the intervention may include improvement in proper-ties of materials or materials, increase in number of headers etc.

b) Use of full penetration welds for header/stub welds and header ligament design improvements

c) Design improvement in the mechanical design of water walls

d) Design improvements to prevent economizer steaming

e) Stress concentration improvements: identification of critical zones, fatigue analysis, operational feedback of regular de-signs; analysis/redesign of water-walls tube/fin system, SH/RH attachments, BRP (boiler recirculation pumps) casing design etc.

f) Water chemistry improvements

g) Vent/drain/spray system sizing improvements

h) Expansion joints design improvements and fatigue tests

i) Refractory improvements

Analysis of designs shall include CFD and FEM investigations. The bid proposal may be developed by the bidder based on earlier studies/investigations. CFD studies and FEM investigation shall be specifically carried out for the equipment/component selected /designed for the subject project/package. Necessary reports for the analysis (CFD and FEM) shall be furnished to the Purchaser. The performance data required for the analysis shall be developed using dynamic modelling for the steam generator.

Visual/NDE protocols additionalities for critical components/equipment, analysis of fatigue damage and load cycling consideration as per the BS-EN 12952-3 or other equivalent code etc.

Results of design analysis which are required to be submitted as part of the Master Drawing List shall be tied up with the Bidder. The Bidder

shall be required to establish the design additionalities (changes in design, dimensions etc.) for making the steam generator suitable for load cycling as part of the bid proposal. The same shall be submitted as a separate document which shall be identified under the MDL. The document shall comprehensively cover each of the above-mentioned areas/components and others identified by the bidder. The process of analysis and results shall include in the document along with conceptual designs. The Bidder shall be required to help Purchaser's engineer run through the complete analysis (as many areas shall not form part of the submitted document).

Periodic inspection shall be carried out by the Bidder during the warranty period of all pre-identified areas with stress concentration. The specifications include thermo-couples and other instruments to collect necessary data for the field test which shall be collected to enable further confirmation of the offered design and/or trouble-shooting. Bidder shall recommend additional instrumentation that may be required for the purpose.

6)

a) Provision for life consumption/Equivalent Operating Hours (EOH) of critical components due to Creep & Fatigue shall be made available online (display in CCR) for Operating personnel. Also program/measures shall be made available online (display in CCR) to guide the operating personnel for maintenance planning.

b) Resulting Damage Factor due to Creep-Fatigue interaction shall be made available online (display in CCR) for Operating personnel.

3.09.00 Functions of HP/LP Bypass System

The HP/LP bypass system is intended for use in the following situations:

a) On hot starts to facilitate matching boiler steam to turbine metal temperatures prior to steam admission to the turbine, thus achieving a faster start up and reduced thermal stresses in the turbine.

b) During cold starts, for Boiler temperature control and condensate conservation.

c) On load rejection - or turbine trips, the bypass system will handle sufficient steam flow to avoid a boiler trip out thus allowing rapid reloading when fault condition clears.

d) The HP bypass system shall serve as pressure relief in case of transient main steam pressure excursion.

3.10.00 Noise Emissions

The plant will be designed and constructed to operate with the least practicable amount of noise.

Suitable acoustical treatment will be provided to ensure that when the plant is operating at any load, the sound noise level (to a reference of 0.0002 microbar) at a distance of 1 meter from the machine or enclosure outline and 1.5 meter above floor level, under any operating condition, does not exceed the more stringent of the following values and those on the Noise Rating curve ISO 85.

An exception will be made for the plant start-up operations or other big pressure reducing devices operating during emergency periods and to the safety valves.

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for equipment specifically listed under clause 4.03.01, Section X, Volume-II A of Technical Specification.

4.00.00 NAME PLATES/RATING PLATES/LABELS

4.01.00 Instruction plates, nameplates (rating plates) or labels shall be permanently attached to each main and auxiliary item of the Plant, including instruments, in a conspicuous position. These plates shall be of stainless steel and shall be engraved with the identifying name, type, identification number and manufacturer's serial number, together with the loading conditions under which the item of plant has been designed to operate.

4.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Bidder shall pay specific attention to the nameplates/labels during painting, so that these are not painted over. Direction of flow is also to be engraved. All actuated valves shall be provided with labels, which shall include the valve and actuator reference number.

4.03.00 All nameplates and labels shall be in English language. All measurements shall be in S.I. units.

4.04.00 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

4.05.00 Nameplates shall be 3 mm thick laminated white, black, white traffolyte for electrical and control panels and stamped stainless steel with lettering of a

minimum height 5 mm for other equipment of each unit. Warning labels and emergency equipment shall have red lettering in place of black. Danger labels shall have red lettering on a white background. Labels shall be of sufficient size to carry a full description of the Main Plant item and its complete KKS identifier. The size and location of nameplates shall be subject to Approval of the Owner. Lettering in all cases shall be machine-made and made to be legible after prolonged time in the range of ambient conditions prevailing at the Site.

4.06.00 Universal designation system utilizing six level breakdown KKS numbering system shall be followed for equipment identification. Each piece of equipment, motor, pump, valve, instrument, switchgear cabinet, junction box, control panel, panel board and associated apparatus shall be provided with tag plates indicating tag number and description. All major equipment (including the steam turbine, condenser, precipitator or fabric filter, main and auxiliary transformers, large pumps, and fans and motors) shall be provided with the data plates, indicating the name of the vendor, type, serial number, year of fabrication, main characteristics, and all further information necessary for a complete identification of the equipment.

4.07.00 All piping shall be painted and/or marked in accordance with the fluid contained according to a power plant color code to be proposed by Bidder and approved by Owner.

4.08.00 Tags shall be fitted by stainless steel self-tapping screws, stainless steel banding such that they are not readily lost or broken during routine operations and maintenance.

4.09.00 Surfaces of labels for cubicles and control equipment shall have a matte or satin finish to avoid dazzle. Colors shall be permanent and free from fading. Danger labels shall have red lettering on a white background. Labels shall be provided on front and rear access doors of all cubicles. Labels shall also be provided inside cubicles to assist the identification of apparatus and terminals.

4.10.00 All lifting beams, cranes, rails, jibs, hoists, slings, straps and other lifting equipment shall be properly tested and permanently marked with their lifting capacity.

5.00.00 SAFETY AND SECURITY

5.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.

5.02.00 Ready and safe access with clear headroom shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.

5.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire hazard or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The Plant layout shall be designed to localize and minimise the effects of any fire hazard or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.

5.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.

6.00.00 GUARDS

6.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.

6.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.

6.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.

6.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.

6.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure handhold must be provided on each side of the opening or doorway.

7.00.00 LOCATION AND LAYOUT REQUIREMENTS

The majority of plant and equipment shall all be of indoor installation. A broad list of buildings housing such equipment is given In Vol-II-G/1. Layout shall facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the plant. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

General Layout and other tender layout drawings enclosed in Volume-II-L [Tender Drawings] show the location of major installations and auxiliary buildings. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Bidder may, subject to Owner's acceptance alter the same to suit the space requirement of the equipment offered.

While developing the layout of buildings the following criteria shall be given effect:

While preparing the detailed layout and deciding upon the transportation and construction/ erection strategy and functional requirements, the following aspects shall be ensured:

a) The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations.

b) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores will be accommodated within the areas available in General Layout Plan.

c) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local by-laws will be complied with.

Minimum clearances/ dimensions

i) Clear Head room within Main Plant Building for pipes, ducts, structures & cable trays etc. : 2.4 m (Minimum)

ii) Clear head room in passage bay between TG hall and first row of boiler column i.e. CD bay : 8 m

d) Deleted

e) Interconnecting walkways per unit:

Interconnecting platform	
Platform between main power house and Boiler	Two (2) nos. of interconnecting walkways (minimum 2.0m clear width) between TG building and boiler (on both side of boiler) at four elevations (minimum) preferably at ground, mezzanine, Operating and PRDS / De-aerator floor level shall be provided by Bidder for side mill/rear mill arrangement.. In case of front mill arrangement the mill bunker building shall be interconnected with 2.0m clear width platform with TG building at two levels (with one level

	necessarily connected with TG Hall operating floor and other interconnection level shall be decided during detailed engineering). The interconnection shall be on both sides of boiler center line for each elevation
Platform between boiler and Coal bunker building	Bunker Building shall be interconnected (1.5m clear width platform) with the respective steam generator at two elevations on either side of the steam generators (preferably at tripper floor leveland feeder floor level) and in each level, floors shall be interconnected to boiler in front as well as in rear sides and two nos.(One on left and one on right side) for front or rear mill arrangement.

f) All piping shall be routed at a clear height of 2500 mm (min.) from the nearest access level to clear man movement.

g) It is envisaged that Generator stator shall be handled by strand jack arrangement/suitable crane arrangement by Bidder during erection.

h). Cable/Pipe trestles height at rail/road crossings shall be 8 M (BOS)

i) A walkway of 750 mm (minimum width) with pipe hand rails & toe guards shall be provided all along length of the trestle for maintenance of cables & pipes. Ladders for approach to these platforms shall be provided near roads, passage ways and turning points.

j) Head room for man movement shall be minimum 2.5 m at ground floor in TG and boiler area and 2.1 m over all platforms. Height of trestles at approach roads to various buildings/facilities shall be 8M. In case building are located in off-site area and are adjacent to each other, then as a good engineering practice, the height of trestle shall be maintained all over as 8.0 M.

k) Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC.

l) Deleted

m) Rolling shutters shall be provided on `A'-row to facilitate the movement of Generator Transformers, Station & Unit transformers to the maintenance bay. Rolling shutter shall be provided for removal of Condenser tubes.

n) Deleted

o) The minimum width of clear access corridors around equipment shall be 1.2 meters.

p) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether

in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.

q) The plinth level with respect to the existing grade level shall be as indicated elsewhere in this specification.

r) The minimum clear height available between two consecutive floor slabs shall not be less than 4.50 meters for Plant buildings and 3.50 meters for Non-Plant buildings, unless specifically mentioned. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.

s) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings(G+2 and above), at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.

t) All buildings shall have provision for toilet (for gents, ladies and Physically challenged) or as specified elsewhere and associated sewage discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified elsewhere in this specification shall be complied with.

u) Top cover over underground pipes/cables shall be minimum one (1) meter. For CW/ACW Pipe, the top cover shall be minimum1.5 M.

v) Cubicle for operating personnel shall be located at safe place near the equipment.

w) Cable racks / pipe racks shall have hand railings in walkways on both sides at appropriate heights.

8.00.00 OPERATION AND MAINTENANCE CONSIDERATIONS

8.01.00 Space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with access ladders shall be provided to facilitate operation and maintenance.

8.02.00 Lifting devices i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling of any equipment and/or part having weight in excess of 200 Kg during erection and maintenance activities. Suitable beams, hooks etc. for this

purpose shall be provided in the buildings and clear space provided below to a platform or floor which will allow normal risk free transport means to be used.

Lifting tackles, slings, etc. to be connected to hook of the hoist/crane shall also be provided by the Bidder for lifting the various equipment and accessories covered under this specification.

8.03.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

9.00.00 MATERIALS

9.01.00 In selecting materials of construction of equipment, the Bidder shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled.

All materials shall be new and shall be of the quality most suited to the proposed application.

9.02.00 Materials used for various components shall be those which have already proven operating experience in similar type of applications.

9.03.00 All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

9.04.00 Prohibited Materials

The use of the following materials is prohibited:

a) High alumina cement in structural elements

b) Wood wool slabs in permanent framework to concrete

c) Calcium chloride in mixtures for use in concrete works

d) Naturally occurring aggregate for use in reinforced concrete that does not comply with the applicable codes and standards.

e) Cast iron for any oil service

f) Carcinogenic material and suspected carcinogenic materials by World Health Organization.

g) Asbestos or any other fibrous form of hydrated magnesium silicate

h) Any other material generally known to be deleterious if used or incorporated in such project like the facility.

10.00.00 LUBRICATION

10.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

10.02.00 Non ferrous capillary tubing shall be used throughout.

10.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

10.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant, which may drop, from operating parts.

10.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

10.06.00 The Bidder shall supply grease gun equipment suitable to service each type of nipple fitted.

11.00.00 LUBRICANTS, SERVO FLUIDS AND CHEMICALS

11.01.00 The Bidder shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Successful Bidder for initial commissioning, first fill and further topping till completion of trail operation. Contractor shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilized during the first year of operation. Further, higher quantities of lubricants, chemicals, consumables etc. as specified elsewhere in specifications shall also be supplied.

11.02.00 The Bidder shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Successful Bidder shall endeavor to reduce the verities and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognized standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

11.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

12.00.00 PLANT LIFE AND MODE OF OPERATION

The complete plant including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of twenty five (25) years under the prevailing site conditions and for the type of duty as specified in relevant sections of the specification.

The critical components of the Steam Generator, Turbine-Generator and Auxiliary equipment, the life of which is limited by time and temperature dependent mechanisms such as thermal stress, creep and low cycle fatigue, are to be designed considering expected (hot, warm and cold) start-up, shut-down and cyclic load variations. (Details are specified in the Volume-II B – Specification of Steam Generator and Auxiliaries and Volume-II C – Specification of Steam Turbine and Auxiliaries)

The units would be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand.

13.00.00 PACKAGING & MARKING

All the equipment 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. While packing the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Bidder shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

Bidder shall conduct his own route survey and transportation logistics for transportation of the equipment to project site by road/rail/sea and indicate the same in his proposal.

Each package shall have identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Bidder shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Bidder, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

14.00.00 PROTECTION

Equipment having antifriction or sleeve bearings shall be protected by weather-tight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.

Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces,

couplings, rotating equipment shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other suitable covering to ensure their full protection. All exposed threaded parts shall be greased and protected with metallic or other suitable protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs shall be sealed and taped. Male threaded openings shall be closed with rough usage covers or plugs shall be sealed and taped. Female threaded openings shall be closed with forged steel plugs.

Returnable containers and special shipping devices shall be returned by the Bidder.

15.00.00 PAINTING

For Painting details, refer Section-XII of this Volume-IIA

16.00.00 COLOUR CO-ORDINATION & FINISH

16.01.00 Exterior surfaces throughout the plant shall be finished in colours and textures which will blend harmoniously together and with the surrounding landscape.

16.02.00 Interior surfaces throughout the plant shall be finished in colours and textures which will blend harmoniously together and which will be conducive to; the comfort, well-being and high productivity of the operators. Operating plant and services provided shall be colour coded for ease of identification.

16.03.00 All finishes shall be durable and as far as possible maintenance free. Finishes shall be easily cleaned.

16.04.00 Final colours and finishes shall be to the acceptance of the Owner.

17.00.00 ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

17.01.00 Environment Protection

The plant shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to restrict pollution from the liquid effluent and stack emission within the limits as given below with due consideration of Environment (Protection) Rules 1986 as amended till date.

The Plant shall be designed meeting the latest environmental requirement issued by MoEF&CC, GOI. In the event of Ministry of Environment & Forest stipulate any other conditions not specified hereunder, the Bidder shall comply with those requirements.

17.01.01 Liquid Effluent Discharge

a) Provision laid down in schedule-I for Thermal Power Plants and also in Schedule-VI. General Standards for discharge of Environmental pollutants Part-A: Effects of Environmental (protection) Rules 1986, as amended till date.

b) Any specific requirement(s) of State Pollution Authorities/Central Pollution Authorities over and above the above stipulation as per the latest norms/stipulations/guidelines issued.

17.01.02 Air Quality, Stack Emissions

a) Suspended Particulate Matter at chimney outlet - Maximum 30 mg/Nm^3 .(on 6% O2 dry basis)

b) Oxides of Nitrogen (NO_x)-100 mg/Nm^3 (Max)(on 6% O2 dry basis)

c) Sulphur di-Oxide(SO_2) -100 mg/Nm^3 (Max) .(on 6% O2 dry basis)

d) Mercury (Hg) - 0.03 mg/Nm^3 (Max)

e) The Efflux velocity from boiler stack(s) shall not be more than 18.3 m/sec.

f) Outlet dust emission level of bag filter installed in AHS and LHS shall be restricted to 18 mg/NM^3.

g) For The Coal Handling Plant, areas covered under Dry Fog Dust Suppression (DFDS)shall be designed to control the dust emission level in the working area measured at distance of 2m from the dust generation sources, over and above the atmosphere background dust level to shall be within 5 mg/NM^3

The Bidder shall include in his scope all necessary equipment and measuring instruments to comply with above requirements. Location and accessibility of the instruments shall be properly coordinated.

17.02.00 Noise Level Requirement

The plant shall be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

a) Maximum noise level shall not exceed 85 dB (A) when measured at 1.0M away from the noise emission source except for the equipment, as listed in clause no. 3.10.00 of this section.

b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, `Ambient Air Quality Standards' in respect of noise.

c) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the Successful Bidder shall comply with the requirement.

18.00.00 INSPECTION AND TESTING

18.01.00 Inspection and Tests during Manufacture

18.01.01 The method and techniques to be used by the Successful Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner are set out elsewhere in this specification.

18.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

18.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

18.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Successful Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The Successful Bidder shall forthwith forward to the Owner/Consultant duly certified copies of the Test Certificates in Three (3) copies for approval.

18.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Owner/Consultant. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner/Consultant.

18.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Successful Bidder shall allow for trial assembly prior to dispatch from place of manufacture.

18.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Owner. The certificates shall include tests for mechanical properties and chemical analysis of representative material.

18.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.

18.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

18.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by the Successful Bidder. Successful Bidder's scope and responsibility shall also include preparation of all necessary documents in the specific formats stipulated by the statutory bodies, coordination and follow up for above approvals.

18.02.00 **Performance Tests at Site**

18.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder are set out elsewhere in this specification. The completely erected System shall be tested by the Successful Bidder on site under normal operating conditions. The Successful Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

18.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

18.02.03 The Successful Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

18.03.00 Special Testing requirements for Imported Items:

1). All equipment, components and parts imported for use in the Power Supply System and Network shall be tested within India to check for any kind of Embedded Malware/Trojans/Cyber threat and for adherence to Indian Standards.

2). All such testing shall be done in certified laboratories that will be designated by the Ministry of Power (MOP).

3). Any import of equipment/components/parts from "prior reference" countries as specified or by persons owned by, controlled by, or subject to the jurisdiction or the directions of these "prior reference" countries shall require prior permission from purchaser as per regulations stated by the Government of India.

4). Where the equipment/components/parts are imported from "prior reference" countries, with special permission, the protocol for testing in certified and designated laboratories shall be approved by the Ministry of Power (MOP).

The above mentioned shall apply to any item imported as a Stand Alone equipment or to be used as a component, or as a part in manufacturing, assembling of any equipment or to be used in power supply system or any activity directly or indirectly related to power supply system.

All the requirements mentioned by MOP, vide letter No. CEA/PLG /R&D/MII/2020, dated 03.07.2020 and other circulars as notified by the Government of India from time to time shall be complied.

18.04.00 For details of specific tests required on individual equipment refers to respective section of this specification.

19.00.00 TRAINING OF OWNER'S PERSONNEL

The Successful Bidder shall extend all possible assistance and co-operation to the Owner regarding the transfer of technology and developing expertise in the area of engineering operation and maintenance of the Plant.

Number of man-days of training as mentioned below shall be included in his Tender.

19.01.00 Training at Successful Bidder's Premises

The Successful Bidder shall conduct training of engineers of the Owner on engineering, operation and maintenance of the Plant at the Successful Bidder's or Associates or Sub Vendor's premises where adequate training facilities are available during the design and manufacturing stage of the successful Bidder.

The total man-months for training of engineers shall be maximum sixty (60), having following indicative break-up:

Discipline	No. of Man-month
Mechanical	40
Electrical	10
Control & Instrumentation	10
	60

However, the details of the training programme will be discussed and finalised with the successful Bidder.

The training may also be arranged by the Successful Bidder in any Plant where the equipment manufactured by the Successful Bidder or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Successful Bidder.

The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the area of engineering, operation and maintenance and as trainers for in-house technology transfer programme of the Owner.

The Successful Bidder shall be responsible for the development of the Training Module and Programme Schedule, which shall be submitted to the Owner for approval.

The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee.

Three (3) sets of the materials included in the training modules shall be handed over to the Owner upon completion of the training. An evaluation shall be jointly undertaken by the Successful Bidder and the Owner's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

The content of the training programme shall include but not be limited to :

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.

2. Plant operation and systems training for operators as applicable.

3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

Said training programme shall be submitted to the Owner for approval.

The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the Plant.

The Successful Bidder shall provide qualified English speaking instructors and training coordinator(s) during the tenure of the training programme.

19.02.00 Operation and Maintenance Training at Site

The Successful Bidder shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Successful Bidder's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final hand over of the Unit. Adequate number of instructors shall be employed at site for this purpose for all the packages / sub systems.

19.03.00 On-the-Job Training

During the period of pre-commissioning, commissioning and trial operation, the Owner shall provide operation and maintenance personnel to assist the Successful Bidder in the operation and maintenance of his supply and work under the direction of the Successful Bidder for the purpose of on-the-job training.

The Owner shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The successful Bidder shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.

19.04.00 Training for 3D model review software

Training for Purchaser’s personnel for 60 man-days (for 10 employees in minimum 2 batches of 5 each) shall be provided at Purchaser’s office at Neyveli / Chennai, for the 3D Model Review Software(s) being offered under the package as stipulated elsewhere in the specification. This is in addition to the training man months detailed in clause 19.01.00 above.

ANNEXURE I

LIST OF STANDARDS FOR REFERENCE

a) International Standards Organisation (ISO).

b) International Electro-technical Commission (IEC).

c) American Society of Mechanical Engineers (ASME).

d) American National Standards Institute (ANSI).

e) American Society for Testing and Materials (ASTM).

f) American Institute of Steel Construction (AISC).

g) American Welding Society (AWS).

h) Architecture Institute of Japan (AIJ).

i) National Fire Protection Association (NFPA).

j) National Electrical Manufacturer's Association (NEMA).

k) Japanese Electro-technical Committee (JEC).

l) Institute of Electrical and Electronics Engineers (IEEE).

m) Federal Occupational Safety and Health Regulations (OSHA).

n) Instrument Society of America (ISA).

o) National Electric Code (NEC).

p) Heat Exchanger Institute (HEI).

q) Tubular Exchanger Manufacturer's Association (TEMA).

r) Hydraulic Institute (HIS).

s) International Electro-Technical Commission Publications.

t) Performance Test Code (PTC).

u) Applicable German Standards (DIN).

v) Applicable British Standards (BS).

w) Applicable Japanese Standards (JIS).

x) Electric Power Research Institute (EPRI).

ANNEXURE I

LIST OF STANDARDS FOR REFERENCE

y) Standards of Manufacturer's Standardization Society (MSS).

z) Bureau of Indian Standards Institution (BIS).

aa) Indian Electricity Rules.

bb) Indian Boiler Regulations (IBR).

cc) Indian Explosives Act.

dd) Indian Factories Act.

ee) Tariff Advisory Committee (TAC) rules.

ff) Emission regulation of Central Pollution Control Board (CPCB).

gg) Pollution Control regulations of Ministry of Environment & Forests, Govt. of India.

hh) Central Board of Irrigation and Power (CBIP) Publications.

ii) National Building Code (NBC).

jj) Indian Road Congress (IRC).

kk) Latest guidelines of Railway Authority.

ll) American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

mm) Sheet Metal and Air Conditioning Contractors Association (SMACNA)

nn) Indian Society of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE)

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CRITERIA FOR LAYOUT

The guidelines will be applied in general, unless otherwise stated in other technical Volumes. In addition to these guidelines, Bidder shall refer the attached Plot Plan, drawing no. 18A03-DWG-M-002A, for tentative arrangement of the various facilities under this package.

	ITEM	SPECIFICATION REQUIREMENT
A.	**Site conditions to be considered**	
1.	Prevalent wind direction during summer (for deciding Cooling Tower orientation)	. See wind-rose in plot plan.
2.	Prevalent wind direction(s) during dry seasons (for deciding the location of coal stock pile and ash dump/ unloading areas, minimising the pollution effect due to dust, ammonia handling and storage system minimising the hazard)	See wind-rose in plot plan.
3.	Location of:	
a)	Water intake point.	From West
b)	Water discharge point.	Not applicable
c)	Plant drainage outfall point(s).	Towards South East
d)	Railway entries & exits.	Not Applicable
e)	Road entries & exits.	From North/South
f)	Electrical power transmission grid system.	Towards South East
g)	Preferred/selected ash dump area.	Towards South
h)	Nearest residential area.	Towards North-East.
i)	Ammonia Handling System	Towards North

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CRITERIA FOR LAYOUT

	ITEM	SPECIFICATION REQUIREMENT
B.	**Layout Requirements**	
1.	Maximum permissible slope in	
a)	Rail track	Not applicable
b)	Road	1 in 30
c)	Sides of unpaved embankment	1 in 2
2.	Required road width	
a)	Main Plant access road 10.0 Metres with 1.5 m wide shoulders on either side.	
b)	Primary roads with access for 500 T crane	10.0 Metres with 1.5 m wide shoulders on either side.
c)	Primary roads without access for 500 T crane	7.5 Metres with 1.5 m wide shoulders on either side
d)	Access ways	7.5 m/4.0 m with 1.5 m / 1.2 m wide shoulders on either side respectively as mentioned in civil spec..
e)	Road to the power house unloading bay :	
	• Only for entry to the unloading bay • To pass through the unloading bay	Yes. No.
3.	Required minimum horizontal distance between the nearest points of	
a)	Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b)	Electrical transformer and any other building/facility	As per the Tariff Advisory Committee Rules.
c)	Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee Rules.
d)	Inflammable liquid (fuel oil,Ammonia etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Expolsives Act) and Indian Petroleum Code.

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CRITERIA FOR LAYOUT

	ITEM	SPECIFICATION REQUIREMENT
4.	Required minimum vertical clearance	
a)	Under pipes/cable racks at road crossings	8.0 Metres.
b)	Soil coverage over underground pipes for CW/ACW piping	1.0 Metre (minimum) 1.5 M
c)	Outdoor Pipe/Cable trench (if required)	150 mm above FGL
d)	Minimum height of equipment (switchgear, cabinet etc.) above floor for HT cable entry	500 mm
e)	Minimum height of equipment (switchgear, cabinet etc.) above floor for LT cable entry	300 mm
5.	Railway Wagon clearance	Not applicable
6.	Minimum Clearance between any road edge and building/structure/ any fixed installation.	Building edge = 6.0 Metres.& Other services = 3.0 meters
7.	Required level, above the local developed grade level, of	
a)	Top of all roads	250 mm.
b)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes.

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CRITERIA FOR LAYOUT

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

1.0 BROAD GUIDELINES FOR LAYOUT PLAN

General layout plan indicating the available spaces for proposed project is as shown in the tender drawing placed in Volume-L of the tender specification. It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope.

While preparing the detailed layout, planning the facilities in the Bidder's scope and deciding upon the transportation and construction/ erection strategy and functional requirements, the Bidder shall ensure the following aspects:

i) The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations.

ii) The entire construction activity shall take into account the commissioning of the units.

iii) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores is to be managed by the Bidder within the areas available in General Layout Plan.

iv) The finished floor level at ground level of the TG building shall be designated at EL. 0.0M and shall be 500mm above the finished ground level (FGL) of that area.

The finished floor level for various areas / facilities shall be as follows:-

FFL of Main Plant Building	-	El. 0.00M
Top of paving for Transformer Yard	-	El. (-) 0.10M
FFL of offsite building	-	500 mm above FGL of respective area

v) All the buildings and facilities shall be approachable by the fire tenders.

vi) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local bye-laws shall be met by the Bidder.

vii) DG Set Exhaust Pipes (Height & Orientation) shall be designed as per Environmental Regulations.

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CRITERIA FOR LAYOUT

1.1 **Main Plant Control Room**

Two (2) nos. Main Plant Control rooms (MPCR) - one control room for unit #1 & common facilities and other control room common for units #2 & #3, shall be provided by the Bidder.

Main Plant Control Rooms / Control Equipment Room/ RIO rooms for each unit shall be provided with air-conditioning by the Bidder.

2.0 **MAIN PLANT LAYOUT REQUIREMENT**

Introduction

The proposed location of main plant block is indicated in the Plot plan drawing enclosed in Volume-II L of the tender specification, however Bidder has to develop layout keeping the location/orientation of the main power block, power evacuation corridor, make-up water corridor, same as indicated in bid document. Bidder shall develop his own layout for the equipment offered and the same to be clearly brought out in the bid under the scope of Bidder. However, while developing the layout the Bidder must give due considerations for the following requirements:

The unit control equipment's room shall be located in the TG building towards boiler side at operating floor level.

The unit control equipment room shall be multi-level and shall essentially house but not be limited to the followings:

i) Unit control panels in control equipment rooms, operator's consoles etc. for all modules. MPCR shall not have any internal column inside the room. Large span roof beams for control room to be adopted and designed.

ii) Computer room with engineering work stations & associated workstations, PADO etc.

iii) Station In charge.

iv) Batteries shall be at mezzanine floor level.

v) Cabling and all other facilities associated with the above system.

vi) SWAS room in TG building.

The Control Rooms, unit control equipment room (CER), computer room with programmer station, PADO room, UPS room, SWAS (Dry Panel) room shall be provided with Air conditioned areas.

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CRITERIA FOR LAYOUT

Washroom/Toilet facilities for ladies & gents separately shall be provided. Further, no vertical bracings, pipes, cable shafts etc. shall be routed through control room or control equipment room area. Design of control room interior including lighting, roof, flooring and decoration will also be provided by the Bidder

2.1 Operating floor inside the main plant building shall match with top level of TG deck.

2.2 Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to:

i) Unit and generator transformers, station transformers, and all Auxiliary transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher.

Oil capacity of individual transformer separating distance (in liters)	Clear (in Meters)
5,000 to 10,000	8.0
Above 10,000 to 20,000	10.0
Above 20,000 to 30,000	12.5
Over 30,000 or more	15.0

ii) In case of auxiliary transformers having an aggregate oil capacity in excess of 2300 liters or more but individual oil capacity of less than 5000 liters, the separating distance between transformers and surrounding building shall be at least 6M unless they are separated by fire separating walls or are protected by high velocity spray system.

3.0 **Layout requirements for Electrical MCC/switchgear rooms**

i) The following clearances shall be maintained for HV/MV Switchboard.

a. Front Clearance

1). For one Row of Swgr - 2.0 M (Min)

2). Between HV/ MV and LV SWGR (front to front). - 2.5 M (Min)

3). For two Rows of Swgr (Front to Front clearance) - 2.5 M (Min)

CRITERIA FOR LAYOUT

b. Back Clearance - 1.0 M (Min.)

c. Side Clearance Min. 1000 mm,

ii) The following clearances shall be maintained for LT Switchboard.

a. Front Clearance

1). For one Row of Swgr - 2.0 M (Min)

2). For two Rows of Swgr (rear to front) - 2.0 M

3). For two Rows of Swgr (Front to Front clearance) - 2.0 M (min)

b. Back Clearance

1). For single/double front - 1.0 M (Min)

c. Side Clearance

Min. 1000 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 1000 mm + width of panel (2 nos. per bus section).

HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same MCC room.

iii) Height of HV/ MV/LT Switchgear Room (bottom to roof beam)

a) With Bus Duct – 4.5 M (min)

b) Without Bus Duct – 4.0 M (min)

4.0 EQUIPMENT LAYOUT REQUIREMENT

4.1 A preliminary layout of the Main Plant along with other auxiliaries, accessories and facilities are enclosed with the Tender Specification. A preliminary cross sectional drawing of the Main Plant is also enclosed. The drawings have been enclosed for Bidder's reference. These drawings are shown after considering the following aspects.

i) AB bay width as 31 M (minimum) and BC bay width as 12 M.(minimum)

ii) Double LP Turbine.

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iii) Double Condenser

iv) Exhausting the steam from Drive Turbine to Main condenser

v) The locations of TDBFPs and MDBFP are in BC bay.

vi) Dual Pressure condenser

4.2 While developing the layouts the Bidder shall give consideration for inclusion of following major layout parameters.

A. Steam Generator Area

Sl.No	Area	Description
1)	Pitch (estimated)	152.0 Meters
2)	Minimum distance between C row of Power house and 1st row of Boiler column(i.e. 1st row of bunker building considering side bunker arrangement)	12.0 Meters
3)	Minimum clearance to be maintained between Adjacent boiler/bunker bay columns and Control Tower building of powerhouse	10.0 Meters.
4)	Minimum distance between last column of boiler and 1st column of ESP	30.0 Meters
5)	Estimated distance between D-row of Boiler Column and chimney centerline.	322.0 Meters.
6)	Minimum clear space required at all working and walking areas for operating & maintenance personnel	

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	i) Horizontal, in all directions	
	a) Adjacent to any electrical equipment, electrical cables, running (rotating/ reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60°C.	1500 mm.
	b) Adjacent to any other plant facilities (including walls /structures)	1000 mm.
	ii) Vertical (head-room clearance)	
	a) Under any pipe/equipment surface of temperature exceeding 60°C and any electrical cables or other electrical items.	2.2 Meters.
	b) Under any other plant facilities (including structures, pipes etc.)	2.5 Meters.
	iii) For all areas where any equipment. (including trucks, trolleys and other material handling equipment) will move or maneuver	Minimum 500 mm from the outer edges of the equipment.
	iv) Minimum clear hand space required for	
	a) The application of thermal insulation	100 mm
	b) Welding work	150 mm
	c) Bolt tightening	150 mm
7)	Floors, platforms, staircase, ladders, walls, doors & windows	
	Statutory Requirement	As per the regulations of OSHA, IBR,Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, PESO, Local Municipal Rules, etc.as applicable.

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8)	Operation & Maintenance Requirement	
	i) Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
	ii) Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments etc. to be operated, observed and/or to be frequently (more than once a month) maintained.	Yes
9)	Other Maintenance Requirement	
	i) Maintenance of the internals/impellers of All important equipment, like mills, all fans of the boiler draft plant, DMCW cooling water pumps, blowers, heat exchangers, fuel oil pumps, filters etc.	Shall be possible without disconnecting or dismantling any piping/ducting.
	ii) Overhauling and handling of the casings for the above items	Shall be possible without disturbing / dismantling any piping /ducting not directly connected to them.
	iii) Crane Approach Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.	Yes

B. Steam Turbine Generator Area

All equipment of steam turbine generator units and ancillary plant shall be installed indoor except the CST:

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Sl. No.	Area	Description
1.	Total TG building length	452 M (minimum) (Total 43 columns with two numbers expansion joint at two places).
2.	No. of unloading bays	Two transverse bays at 0.0 m elevation shall be provided for unloading and maintenance at one end of main plant building. Two additional bay shall be provided between units 1 & 2 and between units 2 & 3 for maintenance at ground floor. Width of maintenance bay shall be 10.5 M (minimum). Further additional bays may be provided as per system/layout requirements.
3.	AB bay & BC bay width	31M (minimum) & 12M (minimum)
4.	CD bay width	In case of Side Bunker arrangement - 12 M (minimum) In case of Inline Bunker arrangement- 3.5 M (minimum)
5	Minimum Clear passage/Pipe cum cable rack width between boiler and turbine bay.	12 M (minimum)
6.	Arrangement of TG set	Longitudinal
7.	No. of minimum floor levels in AB bay. Elevations / Equipment locations shown are indicative.	i. 0.00 M - Finished floor level ii. 0.00 M – Cable Vault iii. 3.5 M – HT switchgear iv. 9M - Mezzanine floor v. 12.3 M LT switchgear vi. 18M - TG floor (Operating Floor)

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8.	No. of minimum floor levels in B-C Bay. Elevations / Equipment locations shown are indicative.	i) 0.00 M - Finished floor ii) 2.0 M BFP Drive Turbine iii) 9.0 M HP heaters 6A & 6B and LP heaters 2 & 3 iv) 9M – Cable Vault v) 12.3 M UPS & Battery Charger vi) 18M Common Control Room, HP heaters – 7A/7B & 8A/8B vii) 24.0 M or above as applicable to house Deaerator storage tank, Air washer room, Aux PRDS viii) 33.0 M –Deaerator tower, , SW/PW tanks, Note: Providing concrete floor to the entire length of main plant building at 33 M level in BC Bay is optional to Bidder. However, Bidder shall provide concrete floor wherever required.
9.	No. of minimum floor levels in C-F Bay. Elevations / Equipment locations shown are indicative.	i) 0.0 M – AC Plant , SWAS Room, Inert Gas room ii9.0 M – Battery Room iii) 14.0 M – Cable Spreader Room iv) 18.0M – Control Equipment Room v) 24.0 M – Cable Spreader Room vi) 27.0 M – Boiler MCC Room vii) 31.0 M- DMCW O/H tank, NaOH solution tank, Air handling units, cooling towers/ softening units for centralized AC system

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10.	Clear walk ways in AB & BC bay & Interconnection with Service Building	Minimum 1.5 m width walkway at all the levels in AB bay on the A row side & B row side. 3.0 m along B-row at operating floor level for interconnection with service building. The Inter-connection platform shall be of Covered type.
11.	Clear Head room in AB & in BC bay	Pipes, cables & equipment's shall be such that a clear head room of not less than 2.5 m above the walkways/ working area is available.
12.	Control Room in BC bay	i) Two (2) nos. Main Plant Control rooms (MPCR) - one control room for unit #1 and common facilities and other control room common for units #2 & #3 as shown in the layout drawing. ii) Location of Control room shall be in B-C bay at operating floor level. iii) Location of Control equipment room shall be on operating floor level in C to F bay as shown in the drawing..
13.	Location of Deaerator (indicative)	In B-C bay at 24.0 M
14.	Location of service water tanks, Potable water tanks (indicative)	In B-C bay at 33.0 M
15.	Location of Condensate Polishing unit(Service vessel)	Preferably in BC bay at 0.00 M
16.	Location of Condensate Polishing unit (Regeneration system)	Outside TG building as shown in General layout drawing
17.	Location of LP chemical Dosing unit (CWT, AVT & OT)	Preferably at 0.00 M.

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18.	Interconnecting platform between main plant building and boiler	As mentioned in Clause 7.00.00.(e) , Section V
19.	Lay down area for maintenance and overhauling.	The layout of the Steam Turbine Generator unit shall permit sufficient lay down area in the operating floor of the respective unit for all the parts/components to enable carrying out maintenance and overhauling operations without any restrictions and without any hindrance to the operating personnel of other units.
20.	Passenger cum goods Lift in TG hall (2000 kg)	2numbers shall be provided in TG building (as shown in plot plan).
21.	Passenger Lift in Service Building (8 persons)	One number shall be provided in the Service Building
22.	Service Building	Please refer Civil Volume II-G/1 & G/2
23.	DG Shed	DG sets with acoustic & weatherproof enclosure shall be installed outside on RCC foundation, with shed and sides open. 4 nos. of 2000 kVA (minimum) DG sets and shall have sufficient space for maintenance, operator & Panels. The tentative Location of DG sets shall be as shown in the plot plan.
24.	AC plant room	These shall be kept as per the tender drawing.
25.	CST (Condensate Storage Tank)	This shall be kept as per the tender drawing.
26.	Clear Head room in Main Plant Building for pipe, Structures & cable trays etc.	2.5 M

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27.	Basement, Pits & Trenches in Main Plant building	Not Acceptable. However in exceptional cases Bidder shall bring out such requirements in his bid and get the approval of the Owner.

4.3 The following clearances to be maintained for C&I DDCMIS/PLC cabinets:

i) Clearance from back - 1200 mm

ii) Clearance from front - 1200 mm

iii) Clearance from side wall - 1000 mm

The above clearances are minimum requirement and may increase with increase in door swing of the cabinets.

4.4 The cable vault space below the HT / LT switchgear room and Control Room shall have 800 mm wide and 2.1 m high movement passage all around the cable trays in the cable vault/ cable spreader room for easy laying/maintenance of cables.

i)	Minimum clear working space Around the equipment	1200mm
ii)	Minimum width of all staircase	1500 mm for all indoor stairs and 1200 mm for outdoor stairs.
iii)	Clear head room in Passage bay between TG hall And first row of boiler column i.e. CD bay	8m
iv)	No. of Fire Escape staircases	As per NBC Part-4-Travel Distance. However, the Fire escape staircases in the main plant with fire doors quantity shall meet the requirement of NBC Part-4. Adequate space and provision for handling/ removal of pumps, motors, heaters, heat-exchanger, fans, Switchgear Panels, Transformers during maintenance shall be provided.
v)	Independent floor drains with separate down comers shall be provided where fire protection system are provided.	

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vi)	In TG bay at crane rail level, chequered plate walkway of minimum 600 mm clear width from face of the column to the hand rail on crane side to be provided for entire A-row & B-row column sectional depth for full length of the building.
vii)	Layout of facilities and equipment shall allow removal of Generator Stator, Generator transformers, Station & Unit transformers without disturbing equipment's, piping, cabling, ducts routed in the area. Adequate space and provision for handling/removal of pumps, motors, heaters, heat- exchanger, fans, Switchgear Panels, Transformers during maintenance shall be provided.
viii)	Valves including actuators and instrument tapping's shall be located in accessible positions and operating/maintenance platform for the same shall be provided. All piping shall be routed at a clear height of 2500mm (min.) from the nearest access level to clear man movement.
ix)	Steam turbine and Generator and other equipment's located in the turbine hall shall be accessible by the EOT cranes for their handling during erection and maintenance. Wherever special handling procedures are to be followed such as for the handling generator stator, rotor withdrawal of Generator etc., during erection, the same shall be under the scope of Bidder and described in written out document and attached with the bid. In case auxiliaries such as BFP are not in the reach of TG hall EOT crane, then separate EOT crane with proper maintenance area shall be provided along with all tools required for removal, assembly & handling of BFPs.
x)	Routing of cable trays & piping including piping & ducting (a) Trestle height in outdoor area shall be 3.0M (BOS) (b) Cable/Pipe trestles height at rail/road crossings shall be 8M (BOS). (c) The pipes including fire water pipes shall be routed over ground either on pedestals or on trestle in plant area. No trenches for pipes shall be envisaged as far as possible. (d) Head room below cable/ pipe rack in transformer yard area for movement of GT shall be such that the same can be moved with bushing installed. A clear gap of 500mm between top of bushing and BOS of the trestle shall be ensured. (e) A walkway of 750 mm (minimum width) with hand rails & toe guards shall be provided all along length of the trestle

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	for maintenance of cables. Ladders/staircase for approach to these platforms shall be provided near roads, passage ways and turning points. (f) Clear Head room for man movement shall be minimum 2.5m at ground floor in TG building area and 2.1m over all platforms for other areas. (g) Height of trestles at approach roads to various buildings/facilities shall be 8 M. In case building are located in off-site area and are adjacent to each other, then as a good engineering practice, the height of trestle shall be maintained all over as 8.0M. (h) Separate cable tray for optical fiber cable / UTP cable shall be provided wherever applicable. (i) The layout shall be developed so as to meet the requirements of the Cabling philosophy indicated separately (Cabling, Earthing & Lightning Protection).
xi)	Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC.
xii)	All cranes including TG EOT cranes shall be provided with approach ladders at least at two places. For the approach to the walk way along B row of TG EOT crane 2 nos. staircase from 24m level (BC BAY) shall be provided, with door in the B Row wall. Where ever cranes can't be maintained in situ on the carriage, facility to draw them to maintenance platforms at girder level as well as provision of suitable platforms shall be considered by the Bidder.
xiii)	For Ventilation requirement from A-row side of TG building, Air Washer room for installation of Air washer units along with pumps shall be considered at suitable location as shown in the general layout drawing. Further, for the remaining Ventilation requirement, Air Washer room for installation of Air washer units along with pumps in BC bay at 24m level (tentatively) for each unit shall be considered. All fresh air ventilation louvers shall be approx 1000 mm from floor level and directed downward at an angle.
xiv)	From the common centralized AC plant separate AHUs (Air handling units) shall be provided for Main plant, & Service building as shown in the general layout drawing/elsewhere in the specification. For further details relevant section of Technical Specifications may be referred.
xv)	All equipment operating maintenance platform including supporting structures such as grating platform in the oil equipment room,

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	control fluid equipment room, valve room, Deaerator, Gland Steam Condenser, Flash tank and for other equipment supplied and erected by the Bidder.
xvi)	Suitable rolling shutters shall be considered in the equipment layout to be developed by the Bidder on `A'-row to facilitate the movement of Generator Transformers, Station & Unit transformers to the maintenance bay. Further rolling shutters at different location shall be provided in TG hall for the movement of material. Rolling shutters shall also be provided along "C" row in TG hall wherever required.
xvii)	All pipe lines shall be routed on pedestals except at road/rail crossings where pipe culverts shall be provided. CW and ACW piping shall be laid below ground as per general layout drawing.
xviii)	A suitable rail track and associated facilities like jacking pads, mooring posts etc. shall be provided to facilitate the movement of Generator Transformers, Station Transformer, Unit Transformers and Unit Auxiliary Transformers to the maintenance bay. These rail tracks shall be accessible from the equipment unloading area of TG bay by a rail track.

5.0 **Lay down area for maintenance and overhauling**.

i) The layout of the Steam Turbine Generator units shall permit sufficient lay down area for all the parts/components to enable carrying out maintenance and overhauling operations without any restrictions and without any hindrance to the operating personnel.

ii) In case any special arrangement for rotor maintenance is required, the same shall be provided by the Bidder.

iii) All handling arrangement including any special arrangements like trolley, drive, pedestals etc. for carrying out maintenance and overhauling for steam turbine generator and its auxiliaries shall be provided by the Bidder.

iv) The Bidder shall furnish general arrangement drawings indicating the equipment lay down area with details such as blocks indicating orientation of dismantled items, travel path etc.

v) The Bidder shall also furnish general arrangement drawings indicating the lay down arrangement of major unit assemblies (provided as spares) in the TG hall with access from EOT crane..

6.0 Local Pits/trenches in Main Plant building are to be avoided. However pits/sumps which are unavoidable such as CW (Circulating Water System)

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pits etc. shall be provided with required dewatering arrangements by means of permanently installed drainage pumps and piping up to the ETP. Bidder shall provide required sump pumps/drainage pumps/submersible pumps & Piping etc.

7.0 Pump shall be permanently fixed in the pits/sumps. If the pit depth is shallow, vertical top mounted sump pumps shall be provided and in deep pits self-priming drainage pumps (horizontal type) at floor level or alternatively submersible type pumps may be provided.

8.0 Each pit/sump shall generally be provided with two numbers (2x100% Capacity) of respective type pumps so that the entire pit is evacuated within 15-20 minutes and the operation of the pumps shall be interlocked through level measurement devices to be installed in the pit/sump so that the pumps shall start automatically and empty the pit.

9.0 The general design and construction features of Vertical sump pumps and Submersible pumps are furnished elsewhere.

10.0 In addition to the above, suitable drainage arrangement of different floors of Main Plant building and Service building, DG set area, Air Conditioning & Ventilation buildings shall be provided. These drains shall be led to the station sumps on the A row and B/C row sides. Sump pumps shall be provided as per the stipulations in Volume II-K of the technical specification. Bidder shall also provide piping, fittings etc. for taking this drain/oily waste water to ETP.

11.0 Bidder to furnish the detailed erection strategy along with the bid for major equipment's located in TG hall.

12.0 Bidder's shall prepare the detailed layout of main power block area indicating the location of all major equipment. The layout shall be furnished along with the bid submitted by the Bidder.

13.0 Valves shall be located in accessible positions.

14.0 Provision of monorails with chain pulley blocks/HOT cranes along with hoist, as required shall be kept.

15.0 Approach for removal of equipment for maintenance shall be provided.

16.0 A/C and ventilation ducts, Bus ducts, and Critical Piping routes to be identified at conceptual stage.

17.0 No cable trenches, under-ground cable vaults and pipe trenches are acceptable in Main Plant as well as interplant cable routing unless otherwise approved by the Owner.

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CRITERIA FOR LAYOUT

18.0 All the pipes and cables within the Plant boundary shall be routed above ground except the Circulating Water Piping and ACW piping (part).

19.0 All other safety requirements as per the factories act shall be observed while developing the layout.

20.0 Battery rooms shall be properly ventilated to release gases produced. An easily accessible wash basin with eye washer shall be provided in the battery room.

21.0 Pipelines shall be routed in such a way to avoid interference with other pipes and their hangers and supports, structure, equipment, electrical conduits, cable trays, ventilation ducts etc. The pipe routing shall also take into account the availability of structural members for providing suitable supports and hangers. Hot and cold premises of the system shall be suitably isolated/ segregated from each other. Routing of oil lines over steam lines shall be avoided. Also the electrical premises shall be fully segregated from system piping.

22.0 Piping layout shall have adequate flexibility to absorb all thermal expansion without causing undue stress in the pipelines.

23.0 All piping shall be grouped where practicable and shall be routed to present a neat appearance.

24.0 The piping shall be arranged to provide clearance for removal of equipment requiring maintenance and for easy access to valves and other piping accessories required for operation and maintenance. Availability of access to valves and specialties shall be properly indicated on the layout drawing.

ANNEXURE-A

COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.

2. There are no deviation(s) with respect to specification other than those furnished in the 'schedule of technical deviations'.

3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.

4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.

5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date: Bidder's Stamp & Signature

ANNEXURE – B

SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Technical Section & Page No	Clause No.	Deviation	Reason / Justification

Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date: Tenderer's Stamp & Signature

Annexure C - INFORMATION TO BE FURNISHED WITH TECHNICAL BID:

Please note the drawing / GTP / catalogue / document submitted with technical bid shall only be treated as tender stage document and the same are not to be scrutinized during tendering process, hence not to be considered as technical approval acceptance.

Please indicate deviation (if any) in schedule of technical deviation only and the same shall only be considered for techno-commercial matter if any arises during contract stage.

Sr.	Particulars	Value
1	Heat Load for 765kV GIS	
2	AC Load	
3	DC Load (Instantaneous load and continuous load)	
4	Required Hook Height	
5	Weight of Heaviest component which may be handled with EOT Crane (for EOT sizing)	
6	Plan & Section Layout of GIS with GIS Building with AutoCAD	
7	GTP	

ANNEXURE-D: CHECKLIST FOR TECHNICAL EVALUATION

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

Sl. No.	Documents to be enclosed	Bidder to confirm (Please tick "Confirmed")
1.	Supporting documents for compliance of Technical Qualifying Requirement.	Confirmed
2.	Unpriced BOQ duly mentioning "Quoted" for all the items, signed and sealed.	Confirmed
3.	Section-4 Annexure- A, Annexure-B & Annexure-C duly signed and sealed	Confirmed

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

The above checklist is reviewed and verified for,

NIT Reference No.:

Name of Bidder:

Name of Project:

Date: Bidder's Stamp & Signature