



**GUJARAT INDUSTRIES POWER COMPANY LIMITED
SURAT LIGNITE POWER PLANT (SLPP)**

VOLUME II — Electrical — Technical Specification- package-A

Design, Engineering, Supply, and Construction of Package A, B, C & D
**New Lignite Feeding System, Associated Works, Contingency Feeding
Arrangement & Dismantling**

Tender No.: GIPCL/SLPP/R&M/LHS/FB-RE/LOCATION/EPC/2026

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Gujarat Industries Power Company Limited
Surat Lignite Power Plant (SLPP), Village: Nani Naroli, Taluka: Mangrol, Dist.:
Surat, Gujarat



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SECTION-1 GENERAL

1. Package A covers Design, Engineering, Procurement, Supply, Fabrication, Erection, Testing, Pre-commissioning, Commissioning, and Handing Over of the New Lignite Feeding System at the Plant End (Feeder Breaker Relocation), on a complete Turnkey EPC basis for the proposed New Lignite Feeding system at Plant end of Surat lignite Power plant, at Village; Nani Naroli, Dist.: Surat in the state of Gujarat, India promoted by M/s. Gujarat Industries Power Company Limited.
2. Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as ELECTRICAL WORKS. The scope of works covered under Electrical works are given in Section 2.
3. The work to be performed under this specification consists of design, engineering as well as providing all materials, consumables, equipment, temporary works and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.
4. The work shall be carried out according to the design/drawings to be developed by the BIDDER and approved by the CONSULTANT/OWNER. For all Electrical installations & equipments, etc., necessary layout, GA drawing and details are to be developed by the BIDDER, keeping in view the statutory & functional requirements of the plant and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Bidder's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the OWNER.
5. BIDDER shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the BIDDER will be construed as evidence that such an examination was made and any later claims / disputes in regard to price quoted shall not be entertained or considered by the OWNER on account of ignorance of prevailing site conditions.



6. STATUTORY REQUIREMENT

Complete Electrical system with all its accessories cover under the scope and the scope also include any statutory approvals (Electrical inspector approval, GETCO/DGVCL approvals etc.), clearances including approval from DGMS if any, required for equipment /system as per standard and system requirements for satisfactory operation. Approval from electrical inspector, GETCO/DGVCL approval means from drawing approval stage up to charging clearance including all stages of approval as per their guidelines and it also includes payment of all kind of charges / statutory fees but necessary letters shall be issued on the letter head of Client. Liasioning with all statutory approving authorities shall be in the scope of Bidder. Statutory body /Act requirements shall be fulfilled by the BIDDER and in case any modifications /additions to the building /Structures are to be made as per the above, shall be carried out by the BIDDER at no extra cost to the owner.

SECTION-2 ELECTRICAL SCOPE OF WORK

Package A covers Design, Engineering, Procurement, Supply, Fabrication, Erection, Testing, Pre-commissioning, Commissioning, and Handing Over of the New Lignite Feeding System at the Plant End (Feeder Breaker Relocation), on a complete Turnkey EPC basis.

SCOPE AND BRIEF DESCRIPTION OF WORK

1. The scope of Bidder shall include design, engineering, supply, loading/unloading, storage in weatherproof shed at site, erection, testing and commissioning in presence of OEM engineer of all electrical equipment required under their scope for New Lignite Feeding System.

The major equipment/system covered under scope of work shall be as follows:

- a. HT & LT Drive motors for all rotating mechanical equipment with gear reducer and coupling for all equipment wherever required.
- b. Variable Frequency Drive panels with all accessories as required.
- c. Control, protection and metering systems including Electrical control Panel.
- d. 6.6 KV HT Switchboard with two (02) Incomers & one (01) Bus coupler scheme.
- e. 415 V LT Switchboard with two (02) Incomers & one (01) Bus coupler scheme.
- f. All HT / LT panels shall be suitable for LOTO system. Bidder shall consider (Subjected to approval of Owner) supply of safety LOTO system for all HT & LT switchgears including supply of LOTO system components like 02 nos. of cabinets for accommodating locks, hasps etc. required number of coloured locks / keys with hasps for permits of Civil (Saffron colour), Mechanical (Yellow colour), Electrical (Red colour), C&I (Blue colour), Operation department (green colour) etc.
- g. Local panels, MLDB, ACDB, local PB control stations, JBs, MKs, MBs, LP etc.
- h. 220V DC system (Batteries (200 AH Plante / Tubular), Battery Chargers, distribution Boards (DCDB), DC Lighting system, battery discharge resistor bank for battery set, general accessories for each battery set)
- i. All HT/LT Power, control, fibre optic and special cables and cable raceway system with necessary fire barriers, fireproof sealing and coating systems.
- j. Cable supporting structures, cable racks, cable trays, cable laying, cable dressing, cable identification/tagging and cable termination, will all require accessories.



- k. Welding sockets / receptacles, Welding distribution boards with required number of outlet sockets for identified areas of entire plant.
- l. Indoor / Outdoor Illumination system for all areas covered in this scope of supply including lighting transformer, MLDBs, lighting panels, high mast towers, poles, lighting fixtures, lamps etc. including entire plant area road lighting, entire plant watch areas, all buildings, various lighting towers across entire area,
- m. Electrics for ventilation, air-conditioning etc.
- n. Installation, erection accessories.
- o. Earthing and Lightning protection for entire area. Chemical treated earth pit shall be provided for all the areas.
- p. Earthing mat with treated / untreated earth pits as per requirement with due approval from Owner / Owners consultant and equipment earthing for all equipment.
- q. Insulating mat as per latest standard for all the areas for all kind of panels.
- r. First aid box, shock treatment chart, danger boards, EXIT signage boards at all locations, Radium signage in front of all HT/LT panels for maintaining safe clearance, Entry restricted sign boards, authorized entry sign boards, Panel number and identification on front as well as rear side of all panels, required capacity arc flash protection suit in MCC room, Safety pull away rod (02 Nos.) in MCC room, LOTO system for all HT / LT panels as approved by Owner / Owner engineer, danger boards for MCC room as well as transformer yard, Feeder identification through painting for all feeders of HT and LT panels, each transformer, each local push button station, each HT motor, each LT motor, each light fitting, Lighting panels, Lighting distribution boards, each welding sockets, welding distribution boards, each air conditioner, each water cooler, each electrical equipment, etc. for all the areas.
- s. Startup and commissioning spares
- t. Essential spares
- u. **Liasioning with Government statutory authorities like Chief Electrical Inspector, Electrical inspector, GETCO, DGVCL etc.**
- v. Energy meters of suggested make & model to incorporate in each HT feeder, Each LT Motor feeder ≥ 55 KW rating & inter-panel communication system cabling / looping of above meters up to one point. This is required to integrate above feeders electrical parameters in our existing EMS system.
- w. Transformer yard shall have fencing and their door shall be provided with appropriate locks & danger signages.
- x. All air conditioning rooms shall have double door arrangement in order to have proper air conditioning effect inside room and to have energy saving.



- y. Whenever or wherever 3-phase 4 wire power supply is required for any system or application then bidder to derive 3-phase 4 wire power supply from 3-phase 3-wire power supply system by providing required capacity isolation transformer and distribution board after approval from Client.
- z. Survey / audit shall be carried out for plant areas for classification of hazardous area and according to hazardous area classification category, electrical equipment shall be supplied and commissioned.
- aa. Bidder shall take care about necessary safety aspects while designing any system or area or layout of the equipment outdoor / indoor considering safety aspects to be taken care as per CEA / CERC / NGT Audit recommendations / Other government authority / Electrical inspector latest guidelines.
- bb. Battery discharge resistor bank, general battery accessories shall be also supplied along with battery set.
- cc. Protection system shall generally be numerical type for all areas and equipment.
- 1.1.** Special tools and tackles required for installation, operation and maintenance of electrical equipment. Bidder shall take approval / clearance from purchaser before mobilization for installation, testing and commissioning with minimum tools and tackles. List of minimum tools and tackle shall be subjected to approval from purchasers / purchaser's Consultant before site mobilization.
- 1.2.** The required no. of service transformers, HT & LT switch gears, and MCCs being planned by the Bidder shall be provided and it shall be subject to approval of Owner/ Owner's Engineer. Similarly, layout of electrical premises shall be provided as per approval of Owner/ Owner's Engineer. The minimum requirement of LT switchgear, transformer and MCCs to be considered is given in subsequent chapters.
- 1.3.** The technical requirement of the main equipment involved as per the system requirement are covered in technical specification section and other appropriate sections forming part of this specification.
- 1.4.** Complete Electrical system with all its accessories cover under the scope and the scope also include any statutory approvals (Electrical inspector approval, GETCO/DGVCL approvals etc.), clearances including approval from DGMS if any, required for equipment /system as per standard and system requirements for satisfactory operation. Approval from electrical inspector, GETCO/DGVCL approval means from drawing approval stage up to charging clearance including all stages of approval as per their guidelines and it also includes payment of all kind of charges / statutory fees but necessary letters shall be issued on the letter head of Client. Liasioning with all statutory approving authorities shall be in the scope of Bidder.
- 1.5.** Auxiliary electrical system studies and design calculations as indicated below and preparation of all drawings (for approval) is all included in



Bidder's scope. Sub-Vendor dwgs shall be reviewed by Main bidder before furnishing to Owner/Owner's engineer for review and approval.

- 1.6.** Bidder has to take care each Electrical installations of existing plant system. Bidder has to carry out cable route mapping survey for existing system cables. Any requirement to rerouting of HT / LT cables, equipment etc. for new feeding system is in scope of bidder i.e. rerouting of cables through rack, underground trench etc. subject to Owner/Owner's engineer for review and approval.

Following studies and design calculations and others as envisaged during detailed engineering shall be performed as per relevant IS/IEC/IEEE:

- System Short circuit analysis
- System Stability studies
- Motor starting studies
- Insulation coordination studies
- Harmonics studies (THD, FHD & SHD)
- Relay Coordination and relay settings including their detailed calculations
- Electrical protection audit
- Fault level calculations at each voltage level
- Load Flow studies
- Earthing & lightning protection design and its calculations
- Service transformer sizing calculations
- LT Transformer sizing calculations
- HT / LT bus bar sizing calculations
- Equipment rating calculations
- CT & PT sizing calculations
- HT and LT Cable sizing calculations
- DC System Sizing calculation
- Lighting design calculations
- Switchgear sizing calculations
- Preparation of General arrangement drawings, Cabling, Lighting, Earthing and lightning protection layouts for entire area.
- Interconnection schedules, Cable schedules, cable termination chart
- Preparation of area illumination layout

2. ELABORATION OF ELECTRICAL SCOPE OF WORK

The scope of work and different design requirement have been given in different chapters however for ease of understanding it is considered in following paras:



2.1. TRANSFORMER

Oil Type LT Transformers

The numbers of LT transformers (6.6 / 0.433 kV) complete with all fittings and accessories shall be provided as per the system requirement for the satisfactory operation of the power plant with due approval of Owner / Owners consultant.

Minimum number of transformers shall be two (02 Nos.). Bidder to finalise the capacity of transformers as per the system requirement with due approval of Owner / Owners consultant.

The capacity of the transformers shall be so selected that in case of outage of any transformer the remaining transformer shall be loaded upto 80% of their rating. Service transformers fed from 6.6 kV switch board shall be provided to meet loads of 415V auxiliaries.

Transformer neutral shall be connect with appropriate rating of NGR.

2.2. SWITCHGEARS

6.6 kV Switchgears

6.6 kV switchboards will be provided with two sections (Thus named Bus A & Bus B). These sections are connected to individual Service Transformers.

Bus PT & Line PT module shall be provided in both bus & line sections.

Each breaker module of the switchgear shall be provided with multi-function Numerical protective relay with Microprocessor based controller having communication facility.

Sufficient number of breaker handling trolley shall be provided for each switchgear panels.

Wherever number of start / stop is on higher side like in motor feeder, instead of breaker feeder, contactor controlled feeder shall be provided.

LOTO system with all accessories as per Client requirement shall be provided for each HT and LT panels.

Sufficient number of spare feeders of each type shall be provided for each bus section of HT and LT switchgear with due approval of Owner engineer.



Design of HT / LT switchgear breaker feeder shall be such that breaker can be taken in service as well as isolated or test position without opening of breaker feeder main door.

Red colour painting is required on front as well as rear side for bus coupler feeder.

White / Yellow colour Zebra painting is required on front as well as rear side for all incomer feeders.

415V Switch gear

415V MCC shall be provided for feeding different motor and auxiliaries, power distribution boards as required for the plant.

Each breaker module of the switchgear will be provided with multi-function microprocessor based numerical protective relay with communication facility.

Loads at 415V MCC shall be feed to;

- i) Lighting transformer with MLDB
- ii) Battery charger (with Changeover Switch)
- iii) ACDB, Welding DB with transformer
- iv) MLDB, Main Lighting DB with transformer
- iv) Lighting Distribution board
- v) VFD drives, Motors, Actuators, Hooters etc.
- vi) Entire plant area road street lighting system, Air conditioning system, Ventilation system, etc.

MLDB (Main Lighting Distribution Board) & ACDB with appropriate rating transformer having two (02) Incomers & change over provision and shall be provided with necessary outgoing feeders to take care the area lighting & 1-ph / 3-ph receptacles system.

The HT & LT Switchgear panels, LDB, ACDB, Welding DB, DC System etc. shall be located in Switchgear room provided.

Every HT/LT switchboard/MCC/PDBs, etc. shall be provided with 20% spare for each type or 1 of each type, whichever is more.

2.3. Electrical Switchgear Room:

The location of switchgear room shall be elevated on 1st floor & ground floor shall be considered as cable cellar room. No underground Cable

trench to be made, only ground floor & above cable route with necessary cable rack shall consider.

Electrical switchgear room regulations require restricted access for qualified personnel, minimum working clearances around equipment (typically 30–36 inches to 5 feet depending on voltage), a fire-resistance rating of 1 to 2 hours for walls and doors, effective cable fire-stopping, and independent, controlled ventilation to keep ambient temperatures safe.

These safety and design mandates are typically governed by national electrical and building codes (such as the NFPA 70 / NEC in the US, or the Central Electricity Authority (CEA) regulations in India).

Core regulatory requirements cover the following areas:

1. Space and Clearance Requirements

Working Space: The working clearance in the direction of access to live parts must be at least 30 to 36 inches (762 to 914 mm) wide, and equipment doors must be able to open at least 90 degrees.

High Voltage Clearances: For medium/high-voltage switchgear (e.g., above 600V up to 13.8kV), working clearances are strictly enforced, often requiring up to 5 feet (1.5 meters) of space.

Headroom: The minimum headroom (vertical clearance) around switchgear is generally 6.5 feet (2 meters).

2. Construction and Fire Safety

Fire Ratings: Switchgear rooms must be constructed with fire-resistant materials. Doors should have a minimum fire rating of 60 to 120 minutes and open outwards.

Cable Penetration: All cable trenches and wall entries must be effectively sealed using fire-stops or intumescent fire barriers to prevent fire from spreading to adjacent areas.

Oil Containment: If oil-filled transformers or equipment (holding 2,000 liters or more of oil) are placed inside or near the room, specific curbed sills and oil-drainage/trapping arrangements are mandated to prevent oil spills from fueling a fire.

3. Environmental and Ventilation Controls

Temperature Maintenance: Switchgear rooms must be well-ventilated (either naturally or mechanically) to ensure ambient temperatures typically do not exceed 40°C to 55°C, as excess heat directly degrades equipment lifespan and capacity.



Independent Ventilation: Ventilation systems for electrical rooms must be independent of the rest of the building's HVAC to prevent the circulation of smoke and toxic gases in the event of an arc flash or fire.

4. Access and Egress

Restricted Access: Entry must be restricted to qualified and authorized personnel only.

Emergency Egress: Depending on the equipment size and room layout, at least one or two unobstructed entrances/exits must be available, with minimum dimensions (often 24 inches wide and 6.5 feet high).

Lighting: Adequate emergency egress and task lighting must be provided according to the National Building Code

2.4. CABLING

All HT/LT XLPE insulated power, control cables for HT/ LT feeders, all auxiliaries, service transformer, MLDB, ACDB, Street Lighting, LT loads of entire plant area auxiliaries, etc. will be provided by bidder.

Numerical relays, battery charger, etc. shall be in this scope of the bidder. Communication cable shall be laid only in separate conduit wherever applicable in order to avoid damage and magnetic interference.

Control cables from HT/LT Switchgears, CT/PTs, auxiliary relays, ECP, MBs, JB, etc to DCS / PLC also shall be supplied, laid and terminated by the bidder.

All HT / LT XLPE insulated power, control cables and cable accessories supporting GI structures, cable installation, cable terminations with necessary junction boxes and fire sealing as well as fire proof coating are under the scope of Bidder for all areas. All HT /LT power, control cable shall be of FRLS type.

Current, Voltage, MW etc. Transducers shall be provided wherever required for the performance monitoring and system requirement.

The entire cable carrier system for entire plant area shall be in bidder's scope.

All control and protection cables required for connection to relays, meters, signaling, alarm, control, monitoring, etc. for the plant area shall be provided, laid and terminated by the Bidder.

The Bidder is responsible for the total implementation of the job.



All erection / installation accessories, cable termination and jointing kits, cable fixing, dressing, tag numbers, route markers, supporting materials for all areas/ equipment.

Bidder to submit the layout indicating location of all major electrical equipment and cable routes. Levels of floor, clearances, entry / exit points, cable structure details to understand their offer clearly.

2.5. MOTORS

All HT motors shall be suitable for 6.6 kV, 3 phase, 50 Hz and LV motors shall be suitable for 415V, 3 Phase, 50 Hz power supply. Motors of rating above 175 kW shall be controlled from HT switchgear through Vacuum Contactor type CB.

Motor of rating up to 175 kW shall be controlled from LT switchgear. LT Motors ≥ 55 KW rating shall be provided with Numerical relay. LT Motor ≥ 30 KW shall be provided with CT & transducers.

6.6 kV/415V AC motors in the scope as per requirement with due approval from Owner engineer.

Variable Frequency Drives with necessary VFD bypass arrangement along with all associated equipment shall be provided as per requirement with due approval from Owner engineer.

2.6. EMERGENCY CONTROL SUPPLY

The Bidder shall provide the following 220V DC system including DCDB for control and protection requirements and 220V DC operated drives:

1x100% float cum boost charger with battery set shall be provided.

Batteries shall be lead acid plante or HDP type of 200 AH rating with adequate back up time.

2.7. EARTHING AND LIGHTNING PROTECTION

Earthing mat shall be provided for complete plant building and outdoor area under the scope of Bidder. Bidder shall also include earthing pits transformers and lightning arrestors and their inter connection with earthing system. The no. of earth pits shall be as per requirement with due approval from Owner / Owners consultant. The complete earthing system shall be provided in all areas, floors etc. in the scope of bidder.

Each earthing pit shall have earthing pit top cover of suitable material and further it shall have separate identification marking plate which shows the data like earthing pit identification, earth pit resistance value, earth pit resistance testing date, testing due date etc. Earth pit identification marking plate shall be designed in a such a way that every



year, we have to only replace identification sticker provided over marking plate with new display data.

For Transformer yard separate earth grid shall be suitably formed and treated earth pits including raisers shall be provided for transformer neutral & body earthing, support structures etc.

Lightning protection system shall be provided for all building and structures covered under the scope (incl. high mast towers). Earthing and Lightning system shall be as per standards and as per system requirement.

2.8. ILLUMINATION

Bidder shall provide complete illumination for all areas of the power plant

The plant shall be provided with necessary indoor and outdoor lighting system (LED lighting). Indoor lighting shall constitute of normal AC lighting, emergency AC lighting and emergency 220V DC lighting. It also includes entire plant area road lighting, high mast lighting towers, conveyor lighting, JNT (Junction tower) lighting, ramp area, feeder breaker area, entrances, racks, cable cellar room, stairs, all building lighting, shed lighting etc., lighting masts as per aviation guidelines.

SECTION-3 ELECTRICAL SYSTEM DESIGN

1. General

Standards

The design, engineering, manufacture, assembly and testing/commissioning as well as performance of the equipment shall conform to the relevant IS specifications (latest revision). In case the Bidder is not in a position to comply fully with certain IS specifications, or in respect of certain items for which there are no IS specifications, the Bidder may base his proposals on IEC/BS/VDE/DIN recommendations or other reputed national or international standards subject to the approval of the Owner / Owners consultant.

All equipment supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of the Government of India, the Government of Gujarat, Indian Electricity Grid Code, DGMS and with the Indian Electricity Rules.

Bidder is also responsible for obtaining all kinds of approval / clearances from government authorities like electrical inspector authorities, DGMS etc. including payment of all necessary fees / dues etc.

Climatic Conditions

The climatic conditions generally prevailing at GIPCL, Surat have already been described in other volume.

Electrical Equipment selection and derating shall generally be based on ambient temperature of 50 deg. C.

The equipment offered shall be suitable for smooth efficient and trouble free service in the tropical humid climate.

This specification is issued for procurement of specified equipment and system preferably from indigenous suppliers who may make use of imported systems / sub-systems / equipment / parts and who have valid collaboration agreement with reputed foreign suppliers with experience in design and supply of similar systems as specified. The Bidder shall furnish division list of supplies from foreign and Indian sources indicating the name of the agency or make against the respective items. It shall be the responsibility of the Bidder to arrange the import licence for the imported items offered and to co-

ordinate the supply of equipment from foreign and Indian sources and execute the contract within the agreed time schedule.

The make of major equipment shall be limited to preferred makes indicated under chapter 'Vendor List'. If the Bidder prefers to supply other than from the vendor list, it should be with the approval of the Owner.

Similar equipment and components shall be of same make, equipments of same type and rating shall be interchangeable.

The Owner has the option of selecting the manufacturers of electrical equipment, instruments and controls and any other specialized items in the interest of standardization and the Bidder shall have to supply equipment of the particular make, if so required.

2. DESIGN CRITERIA

Standard voltage levels

The standardised voltage levels as given in the Table below shall be adopted:

Sl. No.	Description	Voltage level
1.	HT Power supply	6600V, 3 phase, 3 wire 50 Hz, earthed through medium resistance.
2.	LT Power Supply	415V, 3 phase, 3 wire through 6.6 / 0.415 KV Transformers (neutral connected to NGR)
3.	A.C. Drive motors	415V, 3 phase, 3 wire effectively earthed.
4.	Control & protection of HT, LT switchgear	220V, DC 2 wire unearthed
5.	Control supply for all drive modules	110V AC supply by providing control transformer in the panels
6.	Panel lighting and space heaters	240V, 1 phase, 2 wires 50 Hz, A.C. with one point earthed.



7	Welding socket outlets	415V, 3 phase 4 wire 50 Hz, AC (5 pin socket)
8.	1-ph Socket outlets	230V, 1 phase, 3 wire, AC (3 pin socket)

Permissible variations:

The system plant equipment shall be designed suitable for variation in voltage and frequency as indicated in the table below:

Sl. No.	Description	Voltage	Frequency
1.	Permissible variation with rated performance/rated current and control effectiveness maintained	+10% to – 10%, +10% to – 10%, +10% to – 10%	+5% to – 5% for LT system +5% to – 5% for HT system +5% to – 5% for EHV system
2.	Permissible variations for control and regulation equipment with rated performance and control quality maintained.	+/- 10%	+5% to – 5%
3.	Permissible voltage dip at HT motor terminal during starting of HT motor	-15%	-
4.	Permissible voltage dip at LT motor terminal during starting of LT motors	-15%	-
5.	Permissible variation for 220V DC system	-15%, +10%	

Basic insulation levels:

Equipment shall be designed suitable for basic insulation levels as given in the Table below:

Sl. No.	Nominal voltage kV	BIL kV (peak)
1.	6.6 kV	60
2.	0.415 KV	10

Symmetrical short circuit ratings:

The three phase symmetrical short circuit ratings of the switchgear at different voltage levels shall be as indicated in the Table below:

Symmetrical short circuit ratings

Sl .No.	Voltage level	Symmetrical Breaking capacity	Making Capacity
1.	6.6kV	40 kA	100 kA
2.	415 V	50 kA	125 kA
3.	220 V DC	Min. 20 kA	-

The rated short circuit withstand duration for switchgear of 6.6 kV & 415 V shall be 1 sec.

Criteria for selection of voltage levels for motors:

A.C squirrel cage induction motors of ratings up to 175 kW shall be fed at 415 V, 3 phase, 50 Hz, with DOL start as applicable. A.C motors of ratings larger than above shall be connected to the 6.6 kV system.

Motor starting and permissible voltage dips:

Voltage dip on starting of the largest motor shall be limited to 15% of the nominal voltage at the motor terminals.

TESTING:

In addition to all Routine, Acceptance and Type tests, the major equipments should qualify for seismic Zone –III tests or type test report of same rating/type and type test shall be carried out within 5 year OR as per recent CEA guidelines. Type test reports older than 5 years or as per recent CEA guidelines of any equipment, the same type test shall be



carried out on that equipments at Bidder's cost and submitted to customer, shall be in the scope of bidder. The type test report of seismic is valid for the period of five years from the date of test conducted.

Test conducted at site and shop / factory shall be subjected to approval and witness by customer.

Any special tests on major equipment at the time of testing / commissioning at site shall be carried out, also include in the scope of bidder.



SECTION-4 TECHNICAL SPECIFICATIONS

4.1. TECHNICAL SPECIFICATIONS FOR LT SWITCHGEAR

1. SCOPE

- 1.1.** This specification covers design, manufacture, inspection & performance testing at manufacturer's works, delivery for site, including **packing**, forwarding, loading, transportation to site, unloading at site, storage, erection, testing and commissioning of the switchgears / MCC/DBs for feeding the 415 / 240 V AC loads and DC loads.
- 1.2.** 415 V switchgears shall be 3 phases, 3-wire system (neutral connected with NGR at transformer).
- 1.3.** The switchgear shall derive power from the designated service transformers or from 6.6 KV / 0.415 KV Service Transformers.

All LT drives shall be contactor controlled wherever frequent operation of drives are envisaged.

- 1.4.** LT Switchgears and associated MCCs and DBs for the following systems shall be provided:
 - a. power supply requirement to each and every areas (incl. 1-ph & 3-ph receptacles)
 - b. power supply requirement to plant Sump pump system if require
 - c. power supply requirement to plant CCTV / IT infrastructure system
 - d. power supply requirement to entire plant area lighting system, boundary wall lighting, road lighting, area lighting in the form of high mast lighting towers etc.

2. POWER SOURCES FOR 415V SWITCHGEAR

- 2.1.** The switchgear shall derive power from the respective service transformers.
- 2.2.** The Main lighting DB shall derive from Main lighting transformer.
- 2.3.** To feed 3-phase, 4-wire, 63A and 32A welding receptacles, one separate 415V welding distribution board along with transformer of adequate capacity to be provided.
- 2.4.** The switchgears will derive power from the designated service transformers. BIDDER will propose the configuration / sources best suited for the system



without sacrificing the standby philosophy, reliability, flexibility of operations and common load demarcations.

3. POWER RECEPTACLES

3-phase, 4 wire, 5 pin, 63A power receptacle / welding receptacles with RCCB shall be provided with enclosure. 1-phase, 3 wire, 3 pin, 20A power receptacle receptacles with RCCB shall be provided with enclosure. Also, the feasibility of feeding the welding receptacles of other areas shall be preferably from the nearest welding distribution board. The receptacle shall be industrial heavy-duty type and shall have suitable interlock facility for safety. The receptacle shall conform to IS 1293 and the switch to IS 4064. Further quantity can be decided during detailed engineering. One receptacle in all battery rooms shall be provided.

- 3.1.** One 1-ph & 3-ph power / welding receptacle in transformer yard shall be provided. One changeover switch shall be provided in WDB with two incoming power supply. Out of these two-incoming supplies, one shall be fed from two different buses from LT MCC. The WDB incoming feeding capacity, number of outgoing circuits and number of WDB in field area shall be decided during detail engineering.
- 3.2.** However, minimum no. of WDB's in area shall be 02 nos. at different locations with each having outgoing 04 nos. 63A (3-ph) output & 04 nos. 20A (1-ph) outputs preferable of BALS make.
- 3.3.** 3 phase & 1 phase receptacles shall be flame proof entire area.
- 3.4.** 2 nos. welding receptacles (3 phase, 4 wire, 5 pin, 63A) & 2 nos. receptacles (1 phase, 3 pin, 20A) shall be provided on each floor of junction towers, transfer towers, feeder hopper area and switchgear room. The power receptacle shall be flame proof and weather proof. The receptacle shall be provided along the conveyor at a distance of every 50 m, at least one if the length is less than 50m.
- 3.5.** The receptacles shall be flame proof only.

4. FEEDER DETAILS

- 4.1.** Each of the switchgear shall be provided with two bus sections, two incomers and a bus coupler rated for 100% of the loads connected to the switchgear.
- 4.2.** The switchgears shall be provided with suitable number and type of outgoing feeders for the respective auxiliary loads of the area, power



supply feeders to various panels, lighting, space heating panels, control cabinets and all other loads encountered in the plant. In addition, following feeders shall be provided in each bus section of each switchgear. Winding heating, space heating and test supply shall be such that for Bus A, supply shall be taken from Bus B through suitable rated feeders and transformers and vice versa

- (a) Spare feeders: Minimum of one no. feeder of each rating and type
- (b) Bus VT module: 1 No. for each bus section
- (c) 415/240V, 1 phase Transformer module for panel space heating supply - 1 no. on each bus.
- (d) Switchgear test supply module: 1 No.
- (e) 415/240V, 1 phase Transformer module for motor space heating supply - 1 no. on each bus
- (f) 415/240V, 1 phase essential supply module with five Nos. 1 phase outlets: 1 No.
- (g) DC supply alarm module 1 No.
- (h) Line VT module 1 No. for each bus section for indication and synchronising purpose.
- (i) 415V/110V AC 1ph TRF module per bus for 110V ph
- (j) Supply to changeover switch for common maintenance distribution board
- (k) 24V winding heating supply for motors below 30kW

5. SHORT CIRCUIT CURRENTS & CONTINUOUS CURRENTS

- 5.1.** The short circuit current of 415V bus shall be 50kA for 1 sec. The momentary current rating shall be 2.1 times this value.
- 5.2.** The continuous current rating of the bus bars, their incomers, bus couplers of the switchgear which are fed by the transformers shall be rated at the LV side full load current of the corresponding transformers with 20% margin rounded off to the next higher standard rating.
- 5.3.** The continuous current rating of the bus bars, incomers, bus couplers of the switchgear fed from other switchgears shall be the maximum load on the bus due to all the running auxiliaries during any operation condition plus 20% margin rounded off to the next higher standard rating. For the load calculation, load factors to be considered shall be 0.9 for continuous loads, 0.4 for intermittent loads.

6. SPECIFIC REQUIREMENTS



- 6.1.** All the 415V equipments/devices like bus support insulators, CBs, CTs, PTs etc mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions.
- (a) Variation in supply voltage - $\pm 10\%$
 - (b) Variation in supply frequency - $\pm 5\%$
 - (c) Combined voltage and frequency variations:- 10% absolute.
- 6.2.** Switchgear shall be totally enclosed, metal clad, sheet steel fabricated, indoor, floor mounted fully drawout modular type construction (upto 50 KW rating drawout type & motor above 50 KW rating should be fixed type), dust and vermin proof of uniform height of not more than 2450mm, easily extendable on both sides having switchgear designation indicating label's on front and rear, in double front execution in totally draw out. Proper gasketing shall be provided all around the perimeter of the adjacent panels, panel and base frame, removable cover and doors. The switchboard shall be fully compartmentalized conforming to form 3 requirements of IS 8623.
- 6.3.** MCC shall be fed by two incomer and bus coupler.
- 6.4.** Red colour painting is required on front as well as rear side for bus coupler feeder.
- 6.5.** White / Yellow colour Zebra painting is required on front as well as rear side for all incomer feeders.
- 6.6.** Operating devices shall be incorporated only in front of the switchgear.
- 6.7.** Switchgear shall be divided in to distinct vertical section of :-
- (a) Completely Enclosed busbar compartment running horizontally.
 - (b) Individual feeder modules in multi tier arrangements.
 - (c) Enclosed vertical bus bars serving all modules in vertical section.
 - (d) Vertical cable alley covering entire height and minimum 300 mm wide and shall have hinged doors.
 - (e) A horizontal separate enclosure for all-auxiliary power and control bus as required.
- 6.8.** All modules of identical size & type shall be fully interchangeable without any modifications.
- 6.9.** The sheet steel to be used for the metal enclosed switchgear shall be minimum 2.5 mm thick hot rolled or 2 mm cold rolled.
- 6.10.** The cable entry shall be bottom only with separate gland plate for power and control cable. In case of single core cables, gland plate shall be of non magnetic material.
- 6.11.** The MCCBs shall be of current limiting type. When MCCB's are used as short circuit protection devices for motor modules they shall provide type C co-ordination with associated contactor and thermal overload relay as per IS: 8544 under all operating conditions for the all currents upto the design fault current. The MCCBs on upstream and downstream shall be co-



ordinated. Test reports to prove the requirements of Type-C Co-ordination shall be furnished.

- 6.12.** For each switchgear two number 220V DC control supply shall be provided with a manual selection or through auto switching relay (to be finalized during detail engineering) for changing over to either supply. Necessary voltage monitoring contactors (for remote alarm) and indication lamps shall be provided.
- 6.13.** Minimum of one NO and one NC spare contacts of all contactors, relay devices shall be wired to terminal block.
- 6.14.** For CT & VT circuits disconnecting type of terminals shall be provided.
- 6.15.** Terminal arrangements shall be such that all terminals at switchgear ends, which are to be connected to remote alarms and indication at DCS, shall be separated out and shall be kept isolated from other Terminals. 240V AC, 110V AC, 24V DC, 220V DC & other voltages shall be segregated to avoid mix up of voltages. This is specifically required to avoid mixing of switchgear high voltage to C & I low voltage system.
- 6.16.** Secondary of CTs & VTs shall be made through disconnecting type terminals with necessary shorting and earthing facilities. All the control wiring shall be through stud type terminal
- 6.17.** Breakers shall be capable of carrying continuously at least 120% of circuit breaker current at an ambient temperature of 50 deg. and with breaker mounted inside the panel. If a higher rated breaker is necessary to meet this, the same shall be used.
- 6.18.** A clearance of 250 mm shall be maintained between terminal blocks and gland plate and 150 mm between two rows of terminal blocks.
- 6.19.** All the electrical equipment shall be fed from main MCC only and if any specific arrangement is needed, separate panel for that shall be provided in switchgear room.
- 6.20.** All LT panels shall be mounted at least on ISMC 100 channels to prevent ingress of water.
- 6.21.** The cable terminations inside the cable alley shall be completely shrouded.
- 6.22.** Wherever auxiliary relay like RE-300 is used for any purpose, it shall be rated for 250V DC only in 220V DC system. Likewise, Wherever auxiliary relay / contactors used with DC auxiliary supply shall be rated for 250V DC only.

7. CONSTRUCTIONAL FEATURES

- 7.1.** Metal clad Indoor type, double front, single/double tier panels, free standing design, with dust Proof construction. The construction shall be



compartmentalized with metal / insulation partitions between compartments. In case of double tier arrangement, sufficient working space shall be provided in cable chamber to work in one cable termination when the other is in energised condition.

- 7.2.** Sheet steel of not less than 2mm thickness for load bearing members and 1.6mm thickness for other members.
- 7.3.** Wherever there is requirement of top cable entry then separate cable gland plate shall be provided and separate plate for main bus bar maintenance purpose in LT MCC, DCDB, Any ACDB etc. subject to approval from owner.
- 7.4.** Circuit breaker shall be mounted on fully draw out truck with service, test and isolated positions and complete with following safety interlocks and safety shutters with padlock facility:

Truck cannot be moved in or out of cubicle when the breaker is closed.

CB compartment door shall be mechanically interlocked so that it shall not be possible to close the CB in plug position when the door is open.

Insertion of breaker into service position not possible if the shutters are not free.

- 7.5.** Name plate for each incoming, bus coupler and outgoing at front and back on the fixed portion of the panel.
- 7.6.** All panels shall have motor and panel space heaters with independent switch/MCB and cubicle illumination lamp with door switch.
- 7.7.** The back door shall be hinged type.
- 7.8.** Enclosure shall conform to IP42 or better for bus bar rating above 1600A and IP 52 or better for bus bar rating up to 1600A.

The following shall be taken care in LT Switchgear:

- a) In one vertical panel, there shall not be more than one breaker feeder.
- b) Whenever breaker feeder is provided, the front door shall not have any cut out. The status (like spring charge/discharge, ON/OFF, Service/Test) of breaker shall be provided through glass window cutout provided in front door.
- c) Each component of panel shall be accessible for maintenance/ replacement without requirement of shutdown.
- d) For each module/breaker feeder door fixing, screw type arrangement shall be provided (applicable for all type of LT switchgear, MLDB, ACDB, LDB, MP etc.). Plastic knobs shall not be provided anywhere in panel.
- e) For module rack in/ out, flap type arrangement shall only be provided.



- f) Bus bar PVC shrouds shall be provided such that it is very easy to dismantle shrouds during maintenance and again easy to install by providing sufficient space for maintenance purpose.
- g) Cable gland plate in panel shall be provided such that cables for each feeder in each vertical panel shall be terminated and thereafter sufficient space shall remain in gland plate.
- h) In LT MCC, interpanel wiring connections shall be through plug & socket type arrangement only.
- i) In LT MCC, shutter type arrangement shall only be provided for each motor / breaker feeder / SFU or any other type of feeder.
- j) In each vertical bus bar, for taking out power for each feeder, there shall not be any fixed type contacts arrangement in vertical bus bar. Contacts towards module side shall directly enter into vertical bus bar.
- k) For 415V LT MCC, any feeder other than breaker feeder having rating above & including 55kW rating, the module shall not be draw out type but the same shall be fixed type. Breaker feeder invariably draw out type only irrespective of its rating.
- l) All bus bars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength type polyester fibre glass moulded insulators / epoxy insulators. Separate supports shall be provided for each phase bus bar. If common support is provided anti tracking barrier shall be provided between the supports.
- m) All bus bar joints shall be provided with high tensile steel bolts, Belleville / spring washers and nuts so as to ensure good contacts at the joints.
- n) All bus bars shall be colour coded as per IS.
- o) All parts / items of LV switchgear shall be easily accessible so as to have ease in maintenance. Sufficient space shall be provided.
- p) Each Draw out type modules/feeders shall have flap type arrangement instead of rack-out rod for module/feeder rack-out.
- q) Each module/feeder doors have screw type arrangement with door interlock feature for closing door instead of any plastic knobs or other item.

8. BUSBAR

- 8.1.** Three phase, neutral (with atleast 50% rating of main bus bar) and continuous earth Bus. Bus bar and tapping shall be provided with PVC Sleeve.
- 8.2.** Bus bars shall be provided with colour-coded sleeves.
- 8.3.** Rating of horizontal buses shall be in line with incomer rating and vertical bus bar for the compartment shall commensurate with all outgoing feeders.



- 8.4. Temperature rise of bus bars shall not be more than 40 deg. C above ambient of 50 deg. C, Temperature rise of joints shall be as per the relevant standards.
- 8.5. Bus bar and connection shall be of high conductivity Aluminium / Aluminium alloy of suitable hardness and purity complying with as per IS 5082.
- 8.6. All bus connectors shall be silver-plated.

9. AIR CIRCUIT BREAKERS:

9.1. Electrical Features:

- (1) Air break triple pole draw out type conforming to IS 2516-1980.
- (2) Rated continuous current as specified.
- (3) Symmetrical interrupting capacity shall be 50kA.

Performance category	:	P2
Auxiliary contacts	:	6 NO + 6 NC minimum convertible from NO to NC and vice-versa at site
Make and continuous current:		10 amps.
Breaking current:		
AC	-	4 amps at 240 V
DC	-	0.5 amps at 220 V

- (4) Miscellaneous boards rated less than 400A shall be provided with SFU.
- (5) Each circuit breaker cubicle shall be complete with following minimum accessories:-

(A) One spring return TNC switch.

(B) Large size cluster LEDs for following condition of breaker/contactors:-

- (i) "ON"(Red)
- (ii) "OFF" (green)
- (iii) Trip Circuit & relay supervision (White).
- (iv) Spring charged (Blue)
- (v) DC supply supervision (Violet)
- (vi) Breaker in Test/ Service

(C) Limit switched for test and service position interlocking.

(D) Double pole switch for DC control supply and spring charging motor with HRC fuses.



- (E) Anti pumping relay.
- (F) Sufficient terminal blocks.
- (G) Auxiliary relays as required for contact multiplication.
- (H) Breaker contact multiplication relay mechanically latched type.
- (I) Protective relays along with trip circuit supervision relay and master trip relay.
- (J) Meters as indicated elsewhere.
- (K) Required CTs/PTs/CBCTs.
- (L) Space heaters.
- (M) Other associated equipment.

9.2. Operating Mechanism:

- (1) Motor operated mechanism as applicable.
- (2) Spring charged stored energy mechanism to ensure high speed closing and tripping independent of the operating forces.
- (3) Anti pumping and trip free feature.
- (4) Emergency tripping by mechanically operated trip push button (shrouded to prevent accidental tripping directly on the trip bar.)
- (5) Mechanical indication to show:
 - a) Closing spring charged.
 - b) Breaker ON / OFF / TRIP indication.
 - c) Breaker in Test/Service Positions.
- (6) Breaker to close only when spring fully charged.
- (7) Non-reset type operation counter.
- (8) Charging of closing spring by motor.
- (9) Closing by closing coil (operating range 85% to 110% of rated Voltage).
- (10) Spring charging motor and closing & tripping coil suitable for rated control voltage (220 V DC). Tripping by trip coil (operating range 70% to 110% of rated voltage).
 - i. One opening and one closing operation without control supply.
 - ii. Provision also for manual charging with spring charging motor automatically de-coupled as soon as charging handle is inserted.
 - iii. Breaker close/open operation in test position shall be achieved through pushbuttons or TNC switch provided in breaker panel. Breaker ON/OFF indication shall be provided through LED indication lamp.



- iv. Static type built in release shall also be provided.
- v. Local Remote Selector switch (lockable) type to be provided for each breaker panel.

9.3. Draw-out Features:

- a) Distinct position viz. service, test, and isolated with the door closed.
- b) Mechanical position indication and locking / latching facility for all 3 positions.
- c) Power connections – self aligning, plug-in type contacts.
- d) Control connections – sliding or plug socket type, mechanically coupled, to prevent wrong insertion, continuous rating 16 amps minimum.
- e) Automatic safety shutters to prevent accidental contact with live parts when the breaker is withdrawn.
- f) The break contact shall be on the breaker side.

9.4. Safety Interlocks:

- a) Breaker cannot be closed in any intermediate position other than the 3 fixed positions.
- b) With the breaker in closed condition, it cannot be racked in from any of the 3 position to another.
- c) Mechanical stopper to prevent accidental falling while withdrawing.
- d) Breaker cannot be racked in from isolated to 'test' position with the door open together with provision for defeat of this interlocking, however, the door can be closed only when the breaker is brought back to 'isolated' position.
- e) Door can be opened only when breaker is OFF and is in 'Isolated' position.
- f) Remote closing of breaker not permitted with door open.
- g) Insertion of breaker into 'Service' position not possible if the shutters are not free.
- h) Closing action of the CB shall compress the opening spring ready for tripping.
- i) It shall be possible to bring the circuit breaker to isolated position with the help of external lever without opening the compartment door.
- j) It shall not be possible to close the Breaker if stored energy mechanism is not charged. It shall not be possible to close the Breaker if under-voltage release is not energized (if present). It shall not be possible to close the Breaker if OFF – Push Button is locked in off position. It shall not be possible to close the Breaker if crank hole is open.

9.5. Internal Control Wiring



- a) Control Wiring by 1100 V grade PVC insulated, single core stranded copper conductor Fire, Vermin and rodent proof of min. cross section 1.5 sq. mm. for other and for CT/PT wiring shall be with min 2.5 sq.mm conductor for within panel and min 4.0sqmm for across panel/equipment.
- b) Flexible wire, protected against mechanical damage for wiring to door-mounted devices.
- c) Wires identified at each end in accordance with schematic diagrams by interlocked type ferrules.
- d) All connections external to a feeder, the entire auxiliary contacts of the LT breaker and at least 1 NO + 1 NC spare contacts of the relays brought to terminal blocks.
- e) Interconnection between panels of adjacent shipping sections to be brought out to a separate terminal block, wires for interconnection properly labelled, looped and bunched inside the panel for connection at site.
- f) Not more than two connections on any one terminal.
- g) All spare contacts wired up to terminal block of the panels.
- h) 1100 V grade multi-way terminal blocks of non tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
- i) Power and control terminals segregated.
- j) Open type control terminals of minimum rating 10 A suitable to receive 2 nos 2.5 sq. mm copper conductor.
- k) 20% spare terminals in each control terminal block.
- l) Power Terminations:
 - a. Suitable for accepting cables / bus trunking as specified.

10. PROTECTIVE DEVICES

- 10.1.** The circuit breaker shall be provided with the following protective devices with suitable setting ranges.
- Required protections mentioned elsewhere.
 - Shunt Trip coil for remote tripping rated for 220V DC. It should trip at minimum 70% of rated voltage.
- 10.2.** All the control, protection and signalling circuits of each circuit breaker (incoming and outgoing feeders) shall be fed through MCBs and the individual circuits may be protected by HRC fuses or MCCB.

11. CURRENT TRANSFORMER:



- 11.1.** The thermal and dynamic stability current for CTs shall be same as for the air circuit breakers. CT ratio shall be as per system requirement with due approval from Owner / Engineer. Protection and measuring current transformer shall be bar primary / window type with 1A secondary conforming to IS-2705 Part-II-1992 and Part-III-1992 respectively.
- 11.2.** Measuring CTs shall conform to accuracy class of 1 except for incomer feeders from Transformers which shall be 0.5S. The CT ratio shall be as required by the associated measuring instrument. The CTs shall have saturation factor of not less than 1.5 and higher limit shall be compatible with the overload capacity of the instrument connected on the secondary side.
- 11.3.** Protection CTs shall have their accuracy and burden as-required by the protection circuits in which they are used and shall have saturation factor of not less than 20.
- 11.4.** CT shall be of cast resin type. Energy accounting and audit meters shall be of accuracy class not inferior to 1.0S or better class as per CEA regulations. The accuracy of CT / PT shall not be inferior to that of associated meter.

12. POTENTIAL TRANSFORMERS (PTs)

- 12.1.** Line PTs provided on each incomer and Bus PTs provided in the bus shall be of fixed type. The PTs shall be dry epoxy resin moulded type.
- 12.2.** High voltage windings of voltage transformer shall be protected by current limiting HRC fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position.
- 12.3.** Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energized.
- 12.4.** The technical particulars and accuracy class of the PT shall be as per SLD.
- 12.5.** LED indications for voltage availability in line PT and Bus PT modules shall be provided.
- 12.6.** Bus PT over voltage factor shall be 1.9 for 08 hours.

Each PT cubicle shall be complete with following minimum accessories

- (a) PTs shall be fully draw out type with required no of cores and ratios as specified elsewhere.
- (b) Voltmeter with selector switch.
- (c) Under voltage and No voltage relays with timers and fuse fail relays.



- (d) Required auxiliary relays.
- (e) LEDs for voltage indication.
- (f) Auxiliary PTs, as required.
- (g) DC and AC control supply and changeover switches with Short Circuit protection.

13. CONTROL SUPPLY

- 13.1.** Two 220 V DC feeders shall be provided in each board for power supply of control, shunt tripping and annunciation purpose.
- 13.2.** Control supply shall have supervision facility, alarm shall be provided for non-availability of any one of the control supply.
- 13.3.** MCCBs / MCBs shall be provided on incoming sides of supplies. Control buses of two sections shall be connected through auto changeover scheme.
- 13.4.** LEDs shall be provided for the indication purpose.
- 13.5.** Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing / Tripping circuits of each cubicle.

14. CONTACTORS:

- 14.1.** Contactors will break without damage 10 times rated current up to 100 amp rating and 8 times rated current for above 100 amp rating.
- 14.2.** Continuous current will not exceed 2 amp and initial pick up will be limited to 9 amp. Class of insulation will be E or better.
- 14.3.** Drop out voltage will be 45 to 65% of rated voltage and pick up will be 85 to 110%. Contactor duty will be as per system requirement with due approval from Owner / Engineer.

15. TRANSDUCER:

- a) Programmable type transducers shall be provided wherever required. Transducers shall be provided with two de-coupled 4-20 mA output signals, one for meter and one for DDCMIS. Current limiting features shall be provided for all transducers.
- b) Transducers shall be tested as per IEC:600298 or impulse test etc.



- c) All LT drives having KW rating $\Rightarrow$ 30 shall be provided with current transducer for DCS/PCL purpose in addition to local measurement meter.
- d) In addition to above, for Incomers, Tie Feeders, programmable transducers for current and voltage for all three phases MW, MWH, MVA shall be provided.
- e) Digital multifunction meter shall be provided in all Incomers & motor feeders (55KW and above). Multifunction meter CT terminal should be internally shorted after removal of CT terminal plug. All the multi-function meter communication port to be wired in a disconnecting link type terminal & further same shall be made parallel for the complete mcc through inter panel wiring & taken to be extreme left/right end of the switchgear.

16. PROTECTIVE EARTHING:

- 16.1.** Continuous earth bus of minimum size 50 x 6 mm copper or equivalent aluminium / galvanized steel section, designed to carry the peak short circuit and short time fault current as specified.
- 16.2.** Provision at the bottom extending throughout the length of the board, bolted / brazed to the frame work of each panel with an earthing terminal at each end for terminating external earth conductor including provision for termination of cable armouring at earth bus.
- 16.3.** Vertical earth bus for earthing individual functional units.
- 16.4.** All non-current carrying metal work (including metallic cases) of instruments and other panel mounted components effectively bonded to the earth bus.
- 16.5.** Hinged doors earthed through flexible earthing braid of 6 sq. mm. minimum.
- 16.6.** Looping of earth connection resulting in loss of earth connection to other devices when the loop is broken, not permitted.
- 16.7.** Withdrawable units provided with self-aligning, spring loaded, silver plated copper scrapping earth contacts of make before / break after type ensuring earth continuity from service to the test position.

17. BREAKER HANDLING TRUCK

- 17.1.** Three numbers breaker handling trucks for MCC room for withdrawing the breakers from the switch board.
- 17.2.** Height of platform adjustable to suit the levels at which the breakers are mounted.
- 17.3.** Adequate mechanical strength for handling the largest breaker.
- 17.4.** Guide rails and stops.



17.5. Truck shall be hydraulic operated.

18. LT MOTOR CONTROL CENTRES

18.1. Constructional Features

General:

- a) Fully draw-out type with modules having service, test and isolation positions.
- b) Floor mounting, free standing with base channel for fixing on the inserts on the floor.
- c) Double front, totally enclosed, dust and vermin proof.
- d) Degree of protection IP-52 or better, IP-54 for locations in the shops outside rooms.
- e) Sheet steel with thickness not less than 2.0 mm for load bearing and 1.6mm for other members.
- f) Possibility of extension on either end of MCC.
- g) Removable lifting facilities for each transport unit.
- h) Designation plate for each MCC.
- i) Inscription plate for each module.
- j) Length of each transportable unit not more than 2.4 M
- k) All 415V switchgear shall be painted by powder coating process. The paint shed shall be as per painting specifications.
- l) Wherever contactor controlled feeder is provided for LT drive of rating higher than or equal to 55 kW, the feeder shall be invariably fixed type instead of draw-out type.

18.2. Compartment design

- a) Pilot devices operable from the front.
- b) Operating height not to exceed 2000mm.
- c) Vertical wire way to accommodate all cables.
- d) Components and devices accessible from front.
- e) Protection against accidental contact with live parts while doing maintenance work in a compartment and keeping others in service.
- f) Anti rusting, un drilled removable gland plates to be provided.
- g) Cable entry from bottom unless otherwise specified.
- h) Compartment door interlocked with the main power isolating device for safety with provision for defeating it by authorized person.



- i) All compartments to have covering at the bottom to preclude entry of dust, rats, lizards etc.
- j) Space of about 200mm to be left vacant at bottom throughout the length of the MCC for ease of cabling.
- k) Power circuit isolation device to have facility for locking
- l) In test position module control supply shall be disconnected and provision shall be available to test the control circuit through test bus, obtained from separate control transformer provided for this purpose.
- m) Test close/open operations shall be achieved through separate close/open push buttons provided in the modules.
- n) Module ON, OFF & TRIP indications shall be provided through LED indication lamps.
- o) For 415V ESP switchgear, outgoing feeders for ESP fields shall be invariably 3- phase type and not two phase type.

18.3. Busbars

- a) Busbars shall be of aluminium.
- b) Power busbar joints shall be bolted type with spring washers. Bolts and washers shall be cadmium plated.
- c) Busbars shall be 3 phase horizontally or vertically.
- d) Busbar sizes to be selected in accordance with nominal current rating of incoming Circuit breaker for full short-circuit power.
- e) Busbars shall be insulated by colour coded PVC sleeves,
- f) Earth bus shall run throughout the length of MCC at bottom and for each vertical section.
- g) Busbar configuration shall be red-yellow-blue for three phase AC power and red blue for DC control supply from front to back or top to bottom or left to right as viewed from front.
- h) Temperature rise not to exceed 40 degree C above the peak ambient temperature of 50 deg C. Temperature rise of joints shall be as per relevant standards.
- i) Removal of busbars shall be possible without disconnecting external cables.



18.4. Magnetic contactors:

- a) Shall be capable of interrupting ten times the rated current for rated sizes upto 100A and eight times the rated current for larger sizes.
- b) Suitable to carry the prospective short circuit without damage or injurious heating till the protective device operates.
- c) Coil shall be designed for AC. No economy resistors shall be used.
- d) Insulation for coils shall be class 'E' or better.
- e) Shall pick up Positively at voltage between 85% to 110% of rated value.
- f) Drop out shall be not more than 70% of rated value.
- g) For frequently reversing drives, AC 3 rating selected shall be 50% higher than full load current of the motor at the specified duty cycle.
- h) Derated AC4 ratings shall be selected for inching and plugging operation of the drive.
- i) Minimum 2 NO + 2 NC auxiliary contacts with minimum rating of 10A, 415V for rated duty AC-11 and 2A, 220V for rated duty DC-11.
- j) DC contactors shall be provided with adequately rated magnetic blow out coil for effective arc quenching.
- k) For reversible drives, electrically interlocked contactors shall be used.
- l) The following motor feeders shall have contactors with delayed drop-out feature adjustable up to three seconds. Scanner air fan / hydrogen seal oil pump / any other drive recommended by BTG manufacturer.
- m) Wherever contactor controlled feeder is provided for LT drive of rating higher than 30 kW, contactor rating shall be one size higher from their normal rating as per motor FLC.

18.5. Current transformers:

- a) Bar/Window type primaries and 1A (max) secondaries with thermal and dynamic ratings corresponding to the units with which they are used.
- b) Measuring and protective CT accuracy class shall be as per SLD shall be finalised during detail engineering.

18.6. Control transformer



- a) Dry type 415V / 110V

19. OTHER REQUIREMENTS

- a) No motor shall be fed from local control panel. Even small motors shall be controlled through MCCs except single phase motors and sump pump motors.
- b) Bimetal overload relays with single phase preventer shall be provided wherever required along with necessary command, feed back cable, coupling relays etc. Provision shall be made for resetting of Bimetal overload relays without opening the module door. All motors of 30kW and above shall have an ammeter in panel. 20% spare feeders with at least one of each type and rating shall be provided in each switchgear.

20. ACDB / POWER DISTRIBUTION BOARD (PDB)

- a) 415V, 3 phase, 4 wire, of required rating, 50 KA (short time rating for 1 sec.) indoor type with dry type transformer.
- b) Board shall be single/double front, metal clad, front matched, dust and vermin proof, fixed type, compartmentalized and extensible on both sides IP52 type enclosure.
- c) Shall have base channel of size ISMC 75.
- d) Shall have isolated busbar chamber for main busbar at the top, running through out the length of the board. Chamber shall have removable cover.
- e) Cable alley shall have sufficient space for aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical busbar.
- f) Busbars shall have same cross section through out the length. Rating of the neutral busbar shall be 50% of the main busbar. Earth bus bar shall run in bottom chamber throughout the length of the panel.
- g) Shall have switch-fuse Unit triple pole. SFU shall be capable of breaking rated current at 0.3 pf at rated voltage. SFU shall withstand the fault current envisaged for 415V system.



- h) The number of ACDBs and their locations shall be decided based on consumer requirement and shall be finalized during drawing approval stage.
- i) However, the feeder rating and quantity shall be as per system requirement with due approval from Owner / Engineer.
- j) The following feeders shall be provided in 415V ACDB for Owner's use in addition to Bidder's feeders.

250A switch fuse feeders (3 ph) - 2 No.

125A switch fuse feeders (3 ph) - 2 No.

63A switch fuse feeders (3 ph) - 4 Nos.

16A switch fuse feeders (1 ph) - 8 Nos.

32A switch fuse feeders (3 ph) - 4 Nos.

- k) 20% spare feeders of each type and rating shall be provided.

21. SPECIFIC REQUIREMENTS

- 21.1.** All the incomers and Bus couplers of 415V Switchgears and MCCs and outgoing feeders of 415V switchgear shall have ACB and shall be provided with Microprocessor based numerical relays with communication port.
- 21.2.** The scope of supply shall include all the material including all the transducers, interposing relays, and interconnecting cables for the control and monitoring of the switchboards / MCCs from the DCS/PLC system.
- 21.3.** Numerical relay shall have the following functions
 - Protection
 - Metering
 - Monitoring
- 21.4.** Numerical Relays of all modules in a 415V Switchgear/MCCs shall be interfaced to Main plant DCS/ respective Aux Plant PLC through suitable communication link(IEC 60870-103/104/OPC) through redundant Data Concentrator/Gateway. All metering signals and operation of individual protection signals will be monitored at DCS/PLC through this communication link with time resolution of 1sec. Any other hardware/software required for interface of Numerical relays with the DCS shall be in the Bidders scope. Control signals and SER signals shall be hardwired to DCS/PLC and shall be available with time resolution of 1



m sec. The signals to be wired shall be finalized during detail engineering.

- 21.5.** Numerical Relays and DCS/PLC shall have common Protocol for proper communication. The protocol shall be suitable for transferring time stamped data from Numerical relays to DCS/PLC. It is responsibility of the Bidder to co ordinate between the Numerical Relay/Switchgear Vendor and the DCS/PLC Vendor for finalization of protocol to achieve proper interface between Numerical relays and DCS/PLC.
- 21.6.** All numerical relays shall be time synchronized with GPS system and minimum last ten nos. of fault shall be recorded.
- 21.7.** Close, open operations of the control gear in Test position shall be effected for all 0.4 KV modules through Push Buttons provided in the modules.
- 21.8.** All Modules shall have ON, OFF&TRIP indications through LED indication lamp
- 21.9.** The switchgear manufacturer shall coordinate with the DCS/PLC manufacturer for protocols/mapping, procedures, interface and testing.
- 21.10.** All the switchgears / MCCs shall be designed for bottom entry of cable.
- 21.11.** For breaker control in each switchgear 2 Nos. 220V DC control supply shall be provided with auto-change over to either supply.
- 21.12.** 20% spare terminals shall be provided for each module.
- 21.13.** Insulation Level:
 - Rated insulation voltage 1100 V
 - One minute power frequency withstand voltage.
 - 2.5 KV for power circuits.
 - 2 KV for control circuits.
- 21.14.** Clearance in air (minimum)
 - Phase to phase – 25.4 mm
 - Phase to earth – 19.0 mm
- 21.15.** The potential free contacts for drives to be as per drive control philosophy mentioned in relevant C & I section shall be separately hardwired to the TB's for each LT feeder drive.

22. MODULE DETAILS

22.1. Incomers & Bus Couplers

- a) All the switchgears & MCC shall have two incomers and a bus coupler arrangement.
- b) The incomer modules and bus coupler modules of all the switchgear & MCC shall be air circuit breaker controlled.



- c) The incomer modules shall be interlocked with their upstream breaker such that they can be closed only when upstream breaker is closed and trip automatically when upstream breaker is tripped.
- d) The following minimum protections shall be provided with Numerical relay for incomers and bus couplers.
 - 3 phase inverse time over current protection
 - Earth fault protection
- e) CTs shall be provided for protection and metering.
- f) Incomer shall have current transformers as per the requirement.
- g) Ratings of incomers and bus coupler will be same.

22.2. Feeder Modules of MCC:

- a) Feeders for all drives shall consist of only SFU with contactor as applicable according to the details as described in motor feeders. All feeders SFU with contactor as applicable may be provided.
- b) Open/Close/Trip or ON/OFF/Trip indication lamps (LED) for each drive shall be provided.
- c) Control supply of each module shall be taken through dedicated control transformer of ratio 415 / 110V.
- d) Warning markers shall be provided for 'CAUTION EXTERNAL VOLTAGE'
- e) At least 20% of feeder modules of each type & rating subject to a minimum of one module in each bus section shall be provided as spare. Spare modules shall be completely wired up.
- f) 10% of control terminals in each module shall be provided as spare subject to a minimum of 2.
- g) No any MCCB shall be use at any type of feeders for LT switchgear.

23. CHANGEOVER SCHEME

- 23.1.** All the switchgears/MCCs with sectionalised buses shall be normally operated with the bus coupler breakers open.
- 23.2.** Manual changeover/auto changeover between the two normal incomers and their bus-coupler shall be provided with the following features.
- 23.3.** Manual changeover from one incomer to another with momentary paralleling of the two supplies after checking through synchrocheck relay.
- 23.4.** Auto changeover from one incomer to another after trip of first incomer.



- 23.5.** If there is a prolonged under voltage on any one of the bus sections, the respective incoming, breaker shall trip and the bus coupler breaker shall close provided voltage is available on the other bus section. Total changeover time shall not exceed 1.5 seconds. This auto changeover shall be blocked if the incoming breaker had tripped either on a bus fault or manually. Changeover back to the normal source of supply shall be effected manually.
- 23.6.** The automatic transfer circuit shall be controlled over by an auto-manual change-over switch. The bus section breaker shall be allowed to close only if there is no earth fault or O/C fault on affected section of the 415V switchboard bus-bars.
- 23.7.** Manual live changeover facility shall be provided through dedicated ECP / synchronizing panel for all the switchgears. When planned outage of one of the normal incoming supplies is required, the respective incomers shall be tripped automatically after the bus section breaker is closed manually. For this purpose, a selection shall be provided on the CRT in main control room DCS for selecting the incomer to be tripped. Thus, depending on the selection made, incomer to bus section – A or to bus section – B shall be tripped once bus section breaker is closed manually, thus maintaining continuity of supply. Auto / manual changeover / synchronising shall be provided for breakers of BOP area switchgears from respective PLC by developing suitable logic in PLC and the status shall be made available in DCS through suitable communication protocols. However, protection shall be direct hard wired directly to breaker.
- 23.8.** Manual dead bus closing of a bus-coupler after an intentional manual trip/outage due to under voltage of any one incomer shall be possible. However, restoration to normal shall be manual.
- 23.9.** A timer with a time delay on pick up of 0.5. - 5 sec. for annunciation of the running breaker failing to trip within a preset time (i.e. If the two sources remain paralleled for more than a preset time) shall be provided.
- 23.10.** When the normal supply is to be brought back into operation, the incomer breaker shall be closed whereupon the bus coupler shall trip automatically.
- 23.11.** Latest breaker tripping provision shall be included in the change over scheme in addition to annunciation.

24. MOTOR MODULES

- 24.1.** Motors are to be fed by only SFU and contactors through MCC for feeders with contactor as applicable may be provided.
- 24.2.** More than 30kW capacity motor feeders shall be provided with 240V, 1 - phase space heating supply arrangement. The supply for motor and panel space heating shall be derived from nearest LDB.



- 24.3.** Motor modules of rating 30kW above shall have ammeters and transducers for remote metering.
- 24.4.** Each motor feeder of MCC shall be provided with suitably rated 415/110V control transformer, for arranging control supply for the module. All the necessary auxiliary and main contactors shall be provided suitable for this control supply.
- 24.5.** Local start/stop PBs shall be directly wired to respective MCCs. The multiplied contact of Local start/stop push button at MCC shall be wired to Control room with relay isolation for alarm/indication.

25. INSULATING MATE FOR ALL PANELS

Latest 3.3 KV Class A Synthetic (Elastomer) Insulating Mat as per IS:15652:2006 amended up to date with BIS certification mark, CPRI / ERDA tested, Thickness 2.0 mm, CLASS A, suitable for voltage up to 3.3 KV, Size:2 Mtr (L) X 1 Mtr (W) X 2 mm Thick insulating mats to be used for all LT equipments.

Insulating mats shall be fixed on floor against each LT panel with suitable synthetic rubber adhesive.

26. METERING AND PROTECTION

- 26.1.** Numerical relays provided for ACB controlled modules shall have following protection / metering. The minimum protections / metering required for various typical feeders shall include, but not be limited to the following:

ACB Controlled

(a) Incomers

	Protections		Metering
	Overcurrent protection		Current on all the 3 phases
	Earth fault protection		Voltage – phase to phase, phase to neutral
	Under voltage		KW
	REF protection		kWhr
	Back E/F Protection		

(a) **Buscouplers/Tie Feeders**

	Protections		Metering
	Overcurrent protection		Current on all the 3 phases
	Earth fault protection		KW
			KW hr

(c) **Motor feeders**

	Protections		Metering
a	Composite motor protection to cover a minimum of protections such as over current, short circuit, earth fault, locked rotor, Negative phase sequence, thermal overload alarm & trip etc.(for large motors $\geq 110\text{kW}$)		Current Voltage kW KWh

24.2 The minimum protections/metering required for the following feeders shall include, but not limited to the following.

(a) **Bus PT /Line PT Modules**

	Protections		Metering
	Under voltage & No voltage protection		Voltage – phase to phase, phase to neutral
	Fuse failure protection		

(b) **Motor feeders (SFU with Contactors)**

	Protections		Metering
--	--------------------	--	-----------------

a	Bimetallic Thermal Overload relay (with single phase preventer), short circuit protection (through fuse)	Phase current (for motors of rating above 15kW)
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(C) Incoming feeders for ACDB

	Protections	Metering
	Short circuit protection (through fuse)	Phase Current (1 phase)

(d) Outgoing feeders of ACDB

	Protections	Metering
	Short circuit protection (through fuse)	Phase Current (1 phase) for modules rated 63A and above.

27. TESTS

- 27.1.** BIDDER shall submit available type test reports of temperature rise and short circuit tests of similar switchgear. Also, calculations of temperature rise shall be submitted for approval. In case type test certificate for similar equipment is not available or if type test report is older than 05 years, the same shall be conducted in presence of Owner or his representative if Owner so desires.
- 27.2.** Routine tests shall be carried out on all associated equipment supplied with switchgear as per relevant standards. Type test certificates of all associated equipment shall be furnished.

28. TECHNICAL REQUIREMENTS

415V switchgears shall comply with the particulars indicated in the following table:



SL NO.	DESCRIPTION	SPECIFICATION REQUIREMENTS	
(a)	Rated voltage, phases and frequency	415V, 3 phase, 3 wire, 50 Hz.	
(b)	Construction (Main MCC)	Double Front	
(c)	System neutral earthing	NGR	
(d)	Applicable standard	As per section D2.14	
(e)	Reference Ambient air temperature	50°C	
(f)	Material of bus bars	Al. or Al. Alloy	
(g)	Maximum temp. rise of bus bars, droppers and along the run at site reference ambient of 50°C	40°C	
(h)	Short time rating for 1.0 Sec. (kA rms)	50	
(i)	Momentary rating (kA peak)	105	
(j)	Degree of protection as per IS:2147	IP-52 for bus bar rating above 1600A and IP-54 for bus bar rating up to 1600A	
(k)	Thickness of sheet steel in mm(CRGO)		
	(i) Load bearing members	2.0	
	(ii) Non-load bearing members	1.6	
(l)	<i>Colour finish shade as per IS :5</i>	Interior Exterior	Glossy white Pebble grey shade of RAL 7032

Air CIRCUIT BREAKER

- | | | | |
|----|-----------------------|---|--------------------|
| 1. | Service | : | Indoor |
| 2. | Type | : | Air – break |
| 3. | Rated service voltage | : | 415 V $\pm$ 10% |
| 4. | Rated Current | : | As per requirement |



- | | | | |
|-----|--|---|--|
| 5. | Rated frequency | : | 50 Hz $\pm$ 5% |
| 6. | System earthing | : | Solidly grounded |
| 7. | Rated short time withstand
current for 1 sec. | : | 50 KA (r.m.s.) |
| 8. | Rated Symmetrical breaking
current at rated voltage | : | 50 KA (r.m.s.) |
| 9. | Rated making capacity (min) | : | 125 KA |
| 10. | Rated operating duty
for
direct-on-
motors. The
starting current varies
from 6 to 8 times the full load
current at a very low power
factor. | : | The duty of circuit breaker
motor feeder involves
line starting of
motor |
| | | | Frequency of starts of motors:
Three (3) Starts per hour & Two
(2) Consecutive Cold starts and
one (1) hot restart. |
| 11. | Duty cycle | : | O - 3 min - CO-3 min-CO |
| 12. | Operating mechanism | : | Stored energy type. |
| | a) Closing | : | motor wound spring
operated. |
| | b) Opening | : | shunt trip
coil |
| | c) Latching
arrangement | | Mechanically &
Electrically trip free. |
| 13. | Auxiliary Voltage - | | |
| | a) Closing | : | 220V D.C. (85% - 110%) |
| | b) Tripping | : | 220V D.C. (70% - 110%) |



c)	Spring charging motor	:	220 V $\pm$ 10% D.C.
d)	Space heater & lamp	:	240 V $\pm$ 10% AC 50 Hz
14.	Anti-pumping feature feature	:	Electrical anti-pumping shall be provided.
15.	No. of poles	:	3
16.	Aux. Switch contact	:	Min (6 NO + 6 NC)
17.	Mounting	:	Draw-out type transfer truck within switchgear cubicle.
18.	Limits of temp. rise	:	As per IS:2516 part I & II / Sec I
19.	Termination		
	Incomer	:	Cable (bottom)
	Outgoing	:	Armoured aluminium cable
20	Static built in release	:	To be provided
21.	Finish paint	:	pebble grey RAL 7032

HRC FUSES

1.	Type	:	Link type
2.	Reference standard	:	IS : 9224
3.	Rated current	:	As specified
4.	Operation indicator	:	Required
5.	Fuse characteristics	:	Bidder to furnish

MOULDED CASE CIRCUIT BREAKERS

1.	Service	:	Indoor
2.	Type	:	Current limiting
3.	Rated service voltage	:	415 V $\pm$ 10%
4.	Rated Current	:	As per requirement
5.	Rated frequency	:	50 Hz $\pm$ 5%



- | | | | |
|-----|---|---|------------------|
| 6. | System earthing | : | Solidly grounded |
| 7. | Rated short time withstand current for 1 sec. | : | 50 KA (r.m.s.) |
| 8. | Rated Symmetrical breaking current at rated voltage | : | 50 KA (r.m.s.) |
| 9. | Rated making capacity (min) | : | 125 KA |
| 10. | Rated operating duty | : | P2. |
- For motor feeders shall be suitable for motor operation

CONTACTOR

		AC	DC
1.	Service	:Indoor within steel cubicle for maximum system voltage, starting of motors and miscellaneous loads	Indoor within steel cubicle for maximum system voltage, starting of motors and miscellaneous loads
2.	No. Poles	: 3	2
3.	Rated service voltage	; 415 V $\pm$ 10%	220 V (190-240V)
4.	Rated frequency	: 50 Hz $\pm$ 5%	
5.	System earthing	: Solidly grounded	ungrounded
6.	Short time rating	: To be coordinated with fuse	To be coordinated with fuse



		preceding it.	Preceding it.
7.	Continuous current	: To suit motor continuous conditions specified.	To suit motor continuous current rating Conditions specified.
8.	Short circuit level	: 50 KA (rms) at 415V	20 KA at 220V
9.	Location of control	: One point control Logic adopted.	One point control Logic
10.	Control circuit tapped from	: 110V $\pm 10\%$ 1-ph.	220V
		50 Hz $\pm 5\%$ derived from 415/110V control transformer provided in each control module.	power circuit.
11.	Utilisation category	: AC 3 for uni-directional motors AC 4 for Bi-directional Motors.	DC 2 for shunt motors DC 4 for series motors.
12.	Duty Class:		
	Intermittent class for Uni-directional motors (IS:2959)	: 0.1	0.1
	Intermittent class for		



	Bi-directional motors (IS:2959)	:	0.3	-
13.	Aux. Contact requirement	:	Min. 2 NO & 2 NC contacts.	Min 2 NO & 2 NC contacts.
14.	Limits of operation	:		
	a. Closing (pick-up)		85% to 110%	190 - 240V
	b. Dropout	:	Not More than 70% of	Not More than 70%
			rated control voltage	rated control
			voltage	voltage
15.	High voltage test values (one Min. value)			
	a. Main power circuit	:	2.5 KV	1.5 KV
	b. Control & auxiliary circuit volts	:	2.0 KV	1.5 KV
16.	Limits of temperature	:	As per IS:2959	As per IS:2959

CURRENT TRANSFORMERS:

1.	Service	:	Indoor
2.	System	:	415V, 3 phase, 3 wire, 50Hz, Solidly earthed neutral
3.	Type	:	Resin cast
4.	Rated voltage	:	415 V $\pm 10\%$
5.	Quantity required	:	As per requirements of individual feeders and as mentioned in the specification drawings.
6.	Ratio and burden	:	As required, C.T. secondary rating shall be 1 AMP.
7.	Accuracy	:	as per SLD
8.	Power frequency withstand voltage	:	2.5 KV (r.m.s) for one minute.
9.	Rated short time current		

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2	Auxiliary Supply	220V DC for ACBs and 110V AC for MCC only.
3	CT Secondary Current	1Amp.
4	PT Secondary Voltage	110V AC, 3 Phase
5	Ambient Temperature	50°C
6	Degree of protection	IP 54
7	Communication	Compatible with DCS system through suitable connectivity & suitable software.
8	Input & Output	Required number of analog and digital inputs/outputs as per scheme requirement with spare.
9	Metering	Instantaneous and Integrated values as indicated.
10	Protection	Complete protection for Incomer, Tie, Bus coupler, feeders as indicated.
11	Monitoring	Self-diagnostic facility.
12	Facilities to be made available in the relay	- Programming keys for complete access with out computer (built in). - Provision for external programming unit through suitable software and communication ports. - Display unit. - Read/Write set points. - Time & date stamping - Current & Voltage actual values and any other analog measurement. - Event recording with Pre-trip data with starting characteristics. - Statistical data. - Output relays. - Tamper proof security system.

4.2. TECHNICAL SPECIFICATIONS FOR 6.6 KV HT SWITCHGEAR



1. SCOPE

1.1. This specification covers design, manufacture, inspection & performance testing at manufacturer's works, delivery for site, including packing, forwarding, loading, transportation to site, unloading at site, storage, erection, testing and commissioning of the 6.6KV switchgears for feeding the auxiliaries rated for 6600V and service transformers.

1.2. The switchgear will be of metal clad, self standing dust proof construction, indoor cubicle type fitted with Vacuum Circuit breakers / cassette, fully draw-out type. 6.6 kV system will be 3 phase, 3 wire with medium resistance neutral earthing.

2. POWER SOURCES FOR 6.6 kV SWITCHGEAR

2.1. Existing 6.6 KV power source (from LLHS HT Board to LMS system) shall be shifted to both Incomers (one by one from JNT-13). The switchgear shall consist with 2 Incomers & 1 bus coupler scheme.

2.2. Bidder shall make study of voltage dip at the motor end of highest rating under various conditions and shall size the cables for all interconnections to limit the voltage dip within limit.

3. CONSTRUCTION FEATURES

3.1. Mechanical Design

- a) Sheet steel clad, floor mounted free standing design.
- b) Minimum sheet steel thickness: Non-load bearing members 2 mm, other load bearing members 3.0 mm.
- c) Degree of protection IP54/IP42 or better.
- d) Assembled on base channel of structural steel of minimum height 50 mm, painted black.
- e) Earthed metallic barriers between compartments and between vertical sections.
- f) In case of 6.6 KV switchboard the partitions between the breaker compartment and the bus and cable connecting compartment respectively will be made of sheet steel metallic barriers. These plates can carry individual FRP shutter for the primary contact arms.



- g) Wherever bus bars pass through metallic partitions barriers will be provided to prevent travel of arc / fire from one panel to another.
- h) Zinc bichromated and passivated hardware.
- i) Transport unit not larger than 3.2 meters.
- j) Removable lifting arrangement for each transport unit.
- k) Lockable front doors with concealed hinges with the door not forming part of the draw out truck.
- l) Extensibility on both sides of the panel.
- m) Screwed wire mesh for bus bar and CT chambers to prevent accidental contact with live parts.
- n) Bolted type removable sheet steel covers at rear.
- o) Explosion vents for different chambers.
- p) Cable gland plate thickness will be 3.0 mm.
- q) Pressure relief device/ducts/ other mechanisms to be provided to release pressure that builds up in the event of arcing faults inside the cubicle. The HT switchgear and control gear shall be tested for IAC classification AFLR for fault current of 40KA (rms), 1 sec as per IEC 62271-200.
- r) Control cable entry will be from front bottom side. The route of control cable shall be such that the route shall not be part of main bus bar chamber.
- s) CTs will be located such that these are easily accessible.

3.2. **Labels**

- a) Switchboard designation name plate at the centre of the board with letters not less than 50 mm high.
 - b) Panel designation number and feeder identification on each panel, both in front and rear.
 - c) Inscription plate for each feeder on the door.
 - d) Door/front mounted devices to have labels directly below them.
 - e) Labels made on non-rusting metal or 3 ply lamicaid with engraved inscriptions of white letters (minimum 3 mm high) on black ground.
 - f) Label designation and size of lettering subject to approval.
- Bus side and cable side shutters labelled for identification.

- g) **Red colour painting is required on front as well as rear side for bus coupler feeder.**

White / Yellow colour Zebra painting is required on front as well as rear side for all incomer feeders.



3.3. **Surface Treatment**

- All metal parts of the panel to undergo 7 tank process for surface treatment that includes derusting, cleaning, chemically degreasing, pickling in acid, cold rinsing, phosphating and passivating followed by spraying with two coats of zinc oxide primer and baking in oven.
- a)
- b) Final epoxy paint shall be provided. Shade of paint : Electrostatic powder coating of pebble grey colour to shade of RAL 7032 It should match with SPBD.

3.4. **Bus bar and Connections**

- a) Bus bars will be of high conductivity aluminium as per IS: 5082-1981 and sleeved.
- b) Control and auxiliary buses of electrolytic grade copper / copper wires.
- c) The vertical bus rating
- | | | |
|--------------|---|---|
| For incomer | : | Not less than that of horizontal bus |
| For outgoing | : | Not less than that of the outgoing breaker irrespective of relay setting. |
- d) Final operating temperature under continuous operation in enclosure limited to 90 deg.C by thermometer method.
- e) Both horizontal and vertical bus bars to be designed and supported to withstand the thermal and dynamic stress corresponding to rated short time and peak withstand current specified.
- f) Cross section of main horizontal bus to be uniform through out the switchboard and continuous in one transport unit. In 6.6 KV HT Incomer/tie Feeder, for easy dismantling the I/C CT without making the power cable down from the gland plate, the cable shall be glanded through dummy panel
- g) Bus bar arrangement as per IS 375 – 1963
- h) Phase identification by colour in each panel.
- i) Bus bar joints and tap off connections of bolted type with zinc bichromated high tensile steel bolts, nuts and spring washers, fish plates with accessories at the end of a transport unit for site connections. Bus bar joints will be shrouded wherever required.
- j) Bus bar support insulators of non-hygroscopic material having high impact and dielectric strength with an anti tracking contour.
- k) Bus bar configuration will be red, yellow, and blue for three phase AC from front to back or top to bottom or left to right when viewed from front. Bus bar shall be PVC insulated.

3.5. **VCB circuit breaker .**



- a) The CBs offered will be of gang-operated type. The whole equipment will conform to the relevant IS/IEC specifications of the latest publications whether specifically mentioned or not with regard to construction, safety protection, clearance etc
- b) The CBs along with accessories will be mounted in a withdrawable truck. The CBs are meant for direct on-line charging of transformers and starting of motors and for incomers/tie feeders.
- c) The contact arms for connecting the Circuit Breaker's conducting part to the main bus bars and to the cable side will be of copper.
- d) High quality metal oxide surge arresters will be provided with CBs for motor feeders and wherever required.
- e) The wiring for the CBs will be of plug and socket arrangement. The length of the plug cord will be such that the plug can be inserted into the socket only when the breaker is in "service" and "Test" positions but it will be necessary to withdraw the plug from the socket before the breaker truck can be withdrawn from the cubicle.
- f) The CBs will be physically and electrically interchangeable. All similar and removable parts will be interchangeable with each other.
- g) The CBs will be of fully drawout type having test, service and isolated positions with mechanical indication for test and service positions. Breaker draw out from service to test & then from test to isolated position to be done without opening of breaker front door. The breaker will be provided with mechanical indication for ON & OFF. Closing Spring charged & released status and operation counter. The status indications and the operation counter reading will be visible from outside through the inspection window provided in the breaker chamber door.
- h) The operating mechanism will be stored energy type. The status of the closing spring will be such that the spring will be automatically re-charged after the closing operation of the breaker. The closing spring will be charged through 220 V DC spring charging motors. Provision will also be available for manual charging. Each CB will be provided with necessary handle for the same.
- i) Spring charging motor of suitable rating will be provided with necessary limit switches and protection. The motors supplied for all the breakers will be of the same make. The charging time for the motors will not be greater than 15 secs at rated voltage. Motor will be rated for 220 V DC and will operate satisfactorily at all voltage between 85-110% of the rated voltage. Power supply to the spring charging motor will be cut off when the closing spring is charged manually.
- j) The operating mechanism will be trip free Anti-pumping relay has to be provided. The CB will be provided with suitable mechanical close and trip devices. Working parts of the mechanism will be of corrosion resistant material. Bearing pin bolts nuts and other parts will be adequately pinned



and locked to prevent loosening or changing with repeated operation of the breaker.

- k) The CBs will be provided with close release and shunt trip coils. The control supply for the VCBs will be through 220V DC. The close release coil will operate satisfactorily at all values of voltage between 85-110% while the shut trip coils will operate between 70 - 110% of rated voltage.
- l) Provision will be made available in the CB for checking the wear of the main contacts.
- m) Each CB will be provided with auxiliary contacts / limit switches as indicated below.

Sufficient number of auxiliary contacts operated by the breaker mechanism for interlocking / indication / feedback purpose. Auxiliary contacts of the breaker directly operated by the breaker operating mechanism will be capable of carrying a current of 10 Amps continuously in 220 V DC.

Provision will be made available in the switchgear for locking the CBs mechanically in the test and service positions.
- o) Locking arrangement to be provided in each & every feeder for the implementation of lock out / tag out system. Arrangement to be made like that if someone locked after the isolation, breaker can't be moved to test or service position without removing the lock.
- p) All auxiliary contacts of the CB including the spare contacts are to be wired and brought up to the multipin control plug.

Positive earthing of the circuit breaker frame will be maintained with the earth bus in the breaker compartment in test and service positions. The circuit breaker frame will be earthed before the main breaker contacts / control circuit contacts are plugged in the associated stationary contacts.
- q) The following interlocks are to be provided.
 - a) The truck cannot be moved from test to service or vice versa when the breaker is 'ON'.
 - b) The circuit breaker cannot be switched on when the truck is in any position between test and service position.
 - c) The control wiring plug cannot be disconnected from the socket when the breaker is in service position.
 - d) Provision will be made to trip the breaker if tried to draw out when the breaker is in closed condition.
- r) Supporting insulators for the poles will be of epoxy cast resin type and will be able to withstand stresses due to maximum short circuit current.
- s) The bus bars fixed in the breaker will be of electrolytic copper of suitable cross section to withstand a short circuit current of 40 KA/1sec.
- t)



- u) Inter pole insulation will be provided between adjacent poles. All the joints / connections end will be silver plated. Adequate contact pressure will be ensured.
- v) Control wiring for the breaker will be with single core, flexible, 1100V grade insulated wire with multi strand copper conductor of suitable cross section.

4. **MANUAL TRANSFER OF LOADS**

- a) The switchgears will be provided with manual live changeover scheme for planned changeover of supply from any Incomer through bus coupler breaker through check synchronising relay along with parallel tripping and latest breaker tripping features.
The synchronizing panel should be located at some distance from HT switchgear & LT Switchgear panels. It shall consist of all necessary selection of both HT & LT Incomers – Bus coupler breakers for changeover with complete check synch relay scheme with necessary indication lamps on synchronising panel.
- b) The synchronizing panel should also consist individual TNC for controlling (making On / OFF) for all type of transformer & outgoing feeders (other than Motor feeder) for safe remote operation.
- c)

5. **SPARE FEEDERS AND FEEDERS FOR OWNER**

In each of the 6.6 kV switchgears ratings of the spare feeder shall be of the highest rating on the switchboard, following feeders will be provided;

- a) Motor feeder. (02 nos.) – One on each bus
- b) Transformer feeder. (03 no.) – One on Bus – A & Two on Bus-B
- 5.1. c) Outgoing feeder (02 no.) – One on each bus
- d) Incomer feeder (02 nos.) – One on each bus
- e) Bus coupler (01 nos.)
- f) Bus PT (02 nos.) – One on each bus
- g) Line PT for both Incomers

6. **SHORT CIRCUIT CURRENT RATINGS**

- a) The Short circuit current of 6.6kV switchgear & all components will be 40kA for 1 sec.
- b) The momentary current ratings will be 2.55 times of the SC value.
- c) Breaker rating shall be selected based on IEC 56.



- d) Asymmetrical S.C current breaking capacity of the breaker will consider the higher time constant for decay of current in the vicinity of power generating stations and the breaker offered will be suitable for the same.
- e) Calculations for arriving at the time constant at this plant will be furnished to justify breaker selection in accordance with IEC-56.

7. **CONTINUOUS CURRENT RATINGS**

- a) The continuous current rating of the 6.6 kV unit switchgear buses, and their incomer breaker, tie breaker will be the maximum load on the bus due to all the running auxiliaries under boiler MCR conditions plus 20% margin rounded to next higher standard rating.
- b) The continuous current rating of the 6.6 kV station switchgear buses and their incomer breaker, tie breaker will be the maximum load on the bus due to all the running auxiliaries under boiler MCR conditions plus 15% margin rounded to next higher standard rating.
- c) The continuous current rating of the feeders will be based on the name plate current rating of the connected equipment with 15% margin.
- d) The continuous current rating offered shall be rated for design ambient temperature of 50deg C without use of any fans.
- e) The continuous current rating as shown in the key line diagram are the minimum. The BIDDER will increase the continuous current rating after carrying out the calculations as detailed above.
- f) To have interchange ability of breakers, breaker rating shall be standard and limited to two types / current ratings.

8. **CONTROL SUPPLY**

- a) Control supply buses will run through out the switchgear.
- b) Two DC feeders will be taken to each board controlled by MCBs.
- c) In each panel MCB will be used for controlling its DC supply.
- d) Each panel will have one MCB for controlling its AC supply.
- e) All the control, protection and signalling circuits of each circuit breaker (incoming and outgoing feeders) will be fed through MCBs and the individual circuits may be protected by HRC fuses.
- f) Control supply will have supervision facility, alarm will be provided for non-availability of any one of the control supply.



- g) Isolation arrangement will be provided on each panel to facilitate fault location and testing. Separate fuses will be provided for spring charging motors, for indication lamps and for closing & Tripping circuits of each cubicle.

9. **SPECIFIC REQUIREMENTS**

- 9.1. The 6.6 kV circuit breakers shall be vacuum. Rated operating duty of the same shall be 0-3 min-co-3 min-co. on/off control / fault / discrepancy indications for each breaker shall be given. The vacuum breakers shall be provided with adequate over voltage & surge protections.

- 9.2. All feeders shall have local / remote selector switch on Switchgear. Local operation shall be enabled only in test position.

- 9.3. Space heating arrangement for HT motor shall be provided with interlocking scheme to switch off when motor is on. All HT panels shall be mounted on ISMC 100 channels to prevent ingress of water.

- 9.4. Terminal arrangements shall be such that all terminals at switchgear ends which are to be connected to remote alarms and indication at DCS/PLC shall be separated out and shall be kept isolated from other Terminals. 240V AC, 110V AC, 24V DC, 220V DC & other voltages shall be segregated to avoid mix up of voltages. This is specifically required to avoid mixing of switchgear high voltage to C & I low voltage system.

All the 6.6KV equipments/devices like bus support insulators, CBs, CTs, PTs etc mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions:-

- 9.5. Variation in supply voltage - $\pm 10\%$

Variation in supply frequency - -5% to $+3\%$

Combined voltage and frequency variations:- 10% absolute.

- 9.6. Switchgear shall be suitable for easy extension on both the sides. It shall be possible at a later stage to add cubicles on both sides of the switchgear by extending the bus bars.

- 9.7. Secondary of CTs & VTs shall be made through disconnecting type terminals (Elmex make CATD M4) with necessary shorting and earthing facilities. All the control wiring shall be through stud type terminal (CAT M4, Elmex type)



- 9.8. The breaker ratings indicated if in the data sheets referred to the nominal rating of the breaker. However, breakers shall be capable of carrying continuously at least 120% of circuit breaker current at an ambient temperature of 50 deg. and with breaker mounted inside the panel. If a higher rated breaker is necessary to meet this, the same shall be used.
- 9.9. Dummy cubicles with horizontal bus bars, power control and annunciation cable running through the panel, if necessary, to avoid beam interfering with cable openings and to facilitate easy maintenance shall be provided.
- 9.10. All the bolted joints in body of the switchgear shall be earthed through flexible jumpers.
- 9.11. The cable entry shall be bottom only with separate gland plate for power and control cable. In case of single core cables, gland plate shall be of non magnetic material.
- 9.12. All the circuit breakers / vacuum contactors shall be of fully draw out execution with "Test" , "Service" & " Fully withdrawn " positions.
- 9.13. All indicating and integrating instruments, protection and alarm relays, operating and indicating devices shall be visible/ accessible without opening the instrument compartment door. All the hand reset relays shall be mounted on the panel at a conventional height for operation.
- 9.14. The switchgear shall be suitable for bottom cable entry. The height of cable termination shall be such that termination & glanding shall be carried out easily , minimum shall be 700mm.
- All the internal wiring shall be carried out using 1100V grade, stranded copper conductor with PVC insulation and shall be flame, vermin and rodent proof. The minimum size of the copper conductor used for panel wiring shall be as follows:
- 9.15. All circuit except CT & PTs : 1.5 sq mm per lead.
CTs/PTs : 2.5 sq mm/per lead.
- The minimum number of strands per conductor shall be 07. Extra flexible wires shall be used for internal wiring of the Devices mounted on moving parts.
- 9.16. Following colour coding shall be used for internal wiring:-
(a) Red, Yellow & Blue: For respective phase/PT wires.



- (b) Black: For neutral wires.
- (c) Green: For Earth wires, For DC supply wires.
- (d) Red ferruled wires for trip circuit.
- (e) All other with grey coloured wires.

9.17. The inter panel wiring shall be brought out to a separate set of terminal blocks located near the slots meant for inter panel connecting wires. The CT/PT wires for inter panel wiring shall be with minimum 4.0sqmm.

9.18. At least 20% spare terminal shall be provided on each panels and this spare terminals shall be uniformly distributed on all rows of terminal blocks. A clearance of 250 mm shall be maintained between terminal blocks and gland plate and 150 mm between two rows of terminal blocks.

The magnitude of switching surges produced under any and all operating conditions shall not exceed 2.2 P.U. rated peak line to earth voltage with time to crest up to 01 micro seconds for the following conditions:-

- (a) Switching off motor running at full load.
- (b) Switching on, of decelerating motor.
- 9.19. (c) Switching on/off of motor with locked rotor.
- (d) Switching off unloaded transformer.

If the magnitude of the voltage surge produced exceeds this value, the vendor shall provide surge arrestors to restrict the voltage peaks to above mentioned value. The bidder shall furnish along with his bid proof of his breakers / vacuum contactors having been tested at internationally recognised test lab for motor switching duty in addition to all other tests.

9.20. Breakers shall be with motor wound spring operating mechanism. Closing action of the CB shall compress the opening spring ready for tripping.

9.21. Switchgear design shall comprise fully compartment execution having separate vertical sections for each circuit. All the doors, panels, removable covers shall be gasketed all around with neoprene gaskets. All louvers shall have screens with filters. Each switchgear shall be fitted with a label on front and rear of cubicle.

Switchgear shall have separate compartments for the following components

- (a) Set of 3 phase busbars.
- (b) Each of main switching devices.



- (c) Instrument transformers.
- (d) Cable termination.
- (e) Metering and relaying devices.

The partitions of fore listed compartments shall have the following degrees of protection

- Complete protection against approach to live parts or contact with internal moving parts i.e. IPH-6 class for all the above compartments excepts for item (a) i. e. set of busbars.
- Compartments of each set of busbars shall be provided with protection against approach to live parts or contact with internal parts, by tools, wires or similar objects of thickness greater than 1.00 mm i.e. Class IPH – 4.

Each breaker module will be provided with microprocessor based multi function Numerical protective relay with communication port. This Numerical relay will have the following functions

- Protection
- 9.22. • Monitoring
- Metering

Control of the breakers will be through interposing/coupling relays which will be located in Main Plant DCS/respective Aux Plant PLC. Only potential free contact of this IPR will be wired to the control circuit in switchgear.

- 9.23. Switchgear will be suitable for extension on both sides.
- 9.24. An operation counter visible from outside will be provided for each breaker.
- 9.25. For cable side earthing and bus side earthing separate earth trucks will be provided.
- 9.26. All breakers of identical ratings will be interchangeable and suitable mechanical / electromechanical interlocks to ensure that earth switch is not closed / truck is not inserted when the bus or circuit is live will be provided.
- 9.27. Operation of a link carriage will not be possible unless the associated circuit breaker is in the open position.
- 9.28. No live parts will be accessible on opening the circuit breaker compartment door.



- 9.29. Circuit breaker / link carriage will be provided with safety shutters operated automatically by the movement of the circuit breaker / link carriage, to cover the stationary isolated contacts when the breaker /link carriage is withdrawn. Facilities will be provided for locking the shutters positively in the closed position. It will, however be possible to open the shutters intentionally against spring pressure for testing purposes.

- 9.30. The breaker / link carriage will be earthed before the circuit breaker /link reaches the test position from fully withdrawn position. In case of breakers / link carriage with automatic disconnecting type of auxiliary disconnects, the carriage will be earthed before the auxiliary disconnects are made and the carriage earthing will break only after the auxiliary disconnects break.

- 9.31. Caution name plate, "Caution Live Terminals" will be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e., incoming terminals of main link carriage.

- 9.32. Each switchgear will be provided with 2 nos., 220V DC auxiliary power supply feeders each with 100% rating. Provision will be made for changeover facility such that in case of failure of one power source, other will cut in automatically through switching relays or through manual changeover (to be decided during detailed engineering.) Blocking diode should not be provided in DC scheme.

- 9.33. Surge arrestors to be supplied for all motor feeders.

In HT switchgear, sufficient space shall be provided in control cable gland plate for each incomer and tie feeders.

All HT drives shall be contactor controlled wherever frequent operation of drives are envisaged.

- 9.34. Wherever auxiliary relay like RE-300 is used for any purpose, it shall be rated for 250V DC only in 220V DC system, Wherever auxiliary relay / contactors used with DC auxiliary supply shall be rated for 250V DC only.

Whenever blocking diode is provided for the DC system change over arrangement, diode isolation arrangement through MCB at incoming and outgoing for each diode shall be provided.

CUBICAL COMPONENTS AND ACCESSORIES:-

10. (a) One spring return TNC switch.
(b) Large size cluster LEDs for following condition of breaker/contactors:-
(i) "ON"(Red)
(ii) "OFF" (green)
(iii) Trip relay supervision (White).



- (iv) Trip circuit supervision (White)
- (v) Spring charged (Blue)
- (vi) DC supply supervision (Violet)
- (vii) Breaker service position (Red)
- (viii) Breaker test position (Green)
- (c) Limit switched for test and service position interlocking.
- (d) Double pole switch for DC control supply and spring charging motor with HRC fuses
- (e) Anti pumping relay.
- (f) Sufficient terminal blocks
- (g) Auxiliary relays as required for contact multiplication
- (h) Breaker operation counter.
- (i) Protective relays along with trip ckt supervision relay and master trip relay.
- (j) Digital multifunction Meters as indicated elsewhere
- (k) Required CTs, PTs, and CBCTs.
- (l) Surge arrestors/ suppressor, if required.
- (m) Space heaters.
- (n) One Local/Remote Switch.

CIRCUIT BREAKER / BUS BAR EARTHING FACILITIES :-

- a) It shall be possible to connect each ckt or set of three phase bus bars of the switchgears to earth, either through earthing switch or through earthing truck mounted earthing device.
- 10.1.
- b) Earthing switches / Earthing devices shall be mechanically / electrically interlocked with the associated breakers/Isolator to prevent earthing of Live circuits / Bus bars.
 - c) In case the earthing facilities comprises earthing trucks to be inserted in place of circuit breakers, separate earthing truck shall be supplied for each type & size of breakers.

CIRCUIT BREAKER OPERATING MECHANISM:-

Circuit breaker shall be power operated by motor charged spring operating mechanism. It shall be strong, rigid, positive and fast in operation to ensure that: -

- 10.2.
- (a) Main poles of the breaker shall be such that unless otherwise specified, the maximum difference between the instant of contact touching during closing shall not exceed half cycle of rated frequency.
 - (b) Operating mechanism shall be non pumping electrically and mechanically under every method of closing.
 - (c) The closing release shall operate correctly at all values of voltage between 85 and 110% of rated voltage. A shunt trip shall operate



correctly under all operating conditions of the circuit breakers up to the rated breaking capacity of the circuit breaker and all value of supply voltage between 70 & 110% of rated voltage

- (d) After failure of power supply to spring charging motor, at least one open-close-open operation of the circuit breaker shall be possible.
- (e) Closing action of the circuit breaker shall compress the opening spring ready for tripping.
- (f) When closing spring discharged, after closing a beaker, closing spring shall automatically be charged for the next operation.
- (g) Alternative means must be provided to charge the closing spring manually when power supply to motor is not available.

11. **CURRENT TRANSFORMERS**

Separate CTs / CT cores will be provided for:

- Protection
- Metering
- 11.1. • Differential protection of motors (> 1000 KW)
- Differential protection of UAT / SAT.
- Core balance CTs will be provided.

- 11.2. The burden and the parameters of the CTs will be commensurate with the connected loads including lead burdens, changes during engineering stage and 20% spare.

- 11.3. In case of smaller rated CTs (say 300 Amp and less), at the expected fault level, the CT saturation may result in the non-operation of the instantaneous short circuit protection. In such cases, separate protection CT core with higher ratio with separate numerical relay for short circuit protection, selected to avoid saturation at high fault currents will be provided.

- 11.4. C.T's for motor differential protection shall be supplied and fixed at the motor neutral terminal.

- 11.5. Calculations for sizing and selection of various parameters will be submitted for Owner's approval.

12. **VOLTAGE TRANSFORMERS**

- 12.1. Voltage transformers will be provided for incomer and tie feeders. Bus voltage transformer will have separate cubicle.



- 12.2. High voltage side of VTs will have HRC fuses and MCBs on low voltage side. PTs shall be fully draw out type with required no of cores and ratios as specified else where.
- 12.3. Low voltage star winding will have all three phase and neutral connections brought out to terminals and one phase will be earthed.
- 12.4. Insulating levels will be similar to rating of associated board.
- 12.5. Accuracy class 0.5/3P will be used.
 - (a) Under voltage and No voltage relays with timers and fuse fail relays.
 - (b) Tripping relays for tripping of motor feeder on prolonged loss of voltage.
 - (c) Required auxiliary relays.
 - (d) LEDs for voltage indication.
- 12.6.
 - (e) Auxiliary PTs, as required.
 - (f) DC and AC control supply and changeover switches with Short Circuit protection.
 - (g) AC/DC supply supervision LEDs and Relays.
 - (h) Earth fault relay.
 - (i) Voltmeter with selector switch

13. **METERS BUS**

- All HT feeders including spare feeders shall be provided with Digital multi function meters with suitable communication facility of accuracy class 0.5S.CT for the same shall also be 0.5S accuracy class Display in scroll mode for : V, I, Hz, p.f, kW, KVA, KVAR, kWh, shall be available. The meters shall have RS 485 communication port for provision to link to DCS/ Energy management system. Remote metering at DCS/PLC of all metering parameters shall be through numerical relays via Data Concentrators with suitable protocol. Any other hardware or interface modules required for proper interface of the meters with DCS/PLC shall be in Bidders scope.
- 13.1. shall have RS 485 communication port for provision to link to DCS/ Energy management system. Remote metering at DCS/PLC of all metering parameters shall be through numerical relays via Data Concentrators with suitable protocol. Any other hardware or interface modules required for proper interface of the meters with DCS/PLC shall be in Bidders scope.
 - 13.2. Suitable for HT 3 phase, 3 wire application. Multifunction meter CT terminal should be internally shorted after removal of CT terminal plug. All the multi-function meter communication port to the wired in a removable link type terminal & further same shall be made parallel for the complete mcc through inter panel wearing & taken to be extreme left/right end of the switchgear.
 - 13.3. Will be located in the upper part of the panel.



- 13.4. Programmable CT secondary for 5A & 1A & programmable PT secondary.
Control supply shall be provided for 220V DC supply to all HT boards.
13.5. Changeover shall be through relay or manual changeover, to be decided during detailed engineering.
- The numerical relays shall be networked through data concentrators of the main plant and further integrated to DDCMIS/PLC system. Mapping details of all the details shall be submitted in IEC format. Battery back-up for real time clock in the event of power supply failure shall be provided.
- 13.6.

14. **CONTROL**

- 14.1. Close & Open control of the Incomer & Bus coupler breakers will be provided in ECP. For synchronizing, facility shall be provided in the Incomer & Tie feeders using separate check synchronizing relay. Sync-check permissive will be given from this relay for closing of the breaker in case of live changeover from one bus to another bus. Necessary logic will be built in the DCS/PLC for manual live changeover of station to unit bus or vice versa & facilities shall be provided that manual operation can also be done from ECP. All protection tripping will be hard wired.
- 14.2. Close & Open control of all the outgoing breakers to motors will be provided in DCS/PLC.
- 14.3. Close & Open control of all the breakers of service transformers & outgoing feeders will be provided in ECP.
- 14.4. Local operation of the circuit breakers will be possible only in "Test" position.
- 14.5. Number of starts, total running hours for each motor above 100 kW shall be provided on DCS/PLC.
- 14.6. An operation counter visible from outside shall be provided for each breaker. Mechanical locking facility to prevent insertion of breaker if breaker under permit shall be provided.
- 14.7. For cable side earthing and bus side earthing separate earth switches / trucks shall be provided for each 6.6 kV switchgear.
- 14.8. All breakers of identical ratings shall be interchangeable and suitable mechanical / electromechanical interlocks to ensure that earth switch is not closed / truck is not inserted when the bus or circuit is live shall be provided. Safety interlocks to prevent with drawal when breaker in closed position shall be included.



14.8. Operation of an isolator shall not be possible unless the associated circuit breaker is in the open position. Both electrical and mechanical interlocks shall be provided.

14.9. No live parts shall be accessible on opening the circuit breaker compartment door.

14.10.) Circuit breaker / isolator cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker / isolator carriage, to cover the stationary isolated contacts when the breaker / isolator is withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however, be possible to open the shutters intentionally against spring pressure for testing purposes.

14.11. The breaker / isolator carriage shall be earthed before the circuit breaker / isolator reaches the test position from fully withdrawn position. In case of breakers / isolators with automatic disconnecting type of auxiliary disconnects, the carriage shall be earthed before the auxiliary disconnects are made and the carriage earthing shall break only after the auxiliary disconnects break.

14.12. Caution name plate, "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e., incoming terminals of main isolators.

14.13. Each switchgear shall be provided with 2 nos., 220V DC auxiliary power supply feeders each with 100% rating. Provision shall be made for changeover facility such that in case of failure of one power source, other will cut in automatically. Local monitoring of DC supply shall also be provided for DC supply before & after selection through LED.

14.14. All indication lamps shall be LED only.

14.15. Potential free contact of all HT drives local push button station shall be provided to DCS through relay in HT switchgear.

14.16. The potential free contacts for drives to be as per drive control philosophy mentioned in relevant C & I section shall be separately hardwired to the TB's for each HT feeder drive.

INSULATING MATE FOR ALL HT PANELS

15. 11 KV CLASS B Synthetic (Elastomer) Insulating Mat as per IS:15652:2006 amended up to Date with BIS certification mark, CPRI / ERDA tested, Class-B Thickness 2.5 mm suitable for voltage up to 11 KV, Size: 2 Mtr (L) X 1 Mtr



(W) X 2.5 mm thick. Colour : RED, insulating mats to be used for all HT equipments.

Insulating mats shall be fixed on floor against each HT panel with suitable synthetic rubber adhesive.

16. METERING AND PROTECTION

Numerical relays will have following protection / metering for the switchgear panels. The minimum protections / metering required on switchgear as well as DCS/PLC for various typical feeders will include, but not be limited to the following:

(a) Incomers .

	Protections		Metering
•	Inverse time Overcurrent protection	•	
•	Inverse time Earthfault protection	•	
•	Local breaker backup protection	•	kW
•	DC supply failure protection	•	KWh
•	Trip Circuit supervision relay	•	Voltage – phase to phase(all the three phases), phase to neutral
•	Trip Lockout relay	•	Current – on all the three phases
•	Under Voltage Protection	•	
•	No Voltage protection	•	

(b) Bus Coupler

	Protections		Metering
•	Inverse time Overcurrent protection	•	

	Inverse time Earthfault protection	•	
	DC supply failure protection	•	KWh
	Trip Circuit supervision relay	•	Voltage – phase to phase(all the three phases), phase to neutral
	Trip Lockout relay	•	Current – on all the three phases

(c) Bus PT Feeders

	Protections		Metering
•	Under voltage protection	•	
•	Fuse failure protection	•	
•	No Voltage protection	•	Voltage – phase to phase(all the three phases), phase to neutral

(d) Motor feeders

	Protections		Metering
•	Composite motor protection (99) to cover a minimum of protections such as over current, earth fault, locked rotor, Excess long start, Short circuit, negative phase sequence, Thermal alarm, core balance etc.,	•	Current – on all the three phases
•	Differential protection for motor feeders (rated 1000kW or above)	•	kW
•		•	kWh

(e) Service Transformer & Outgoing Feeders

	Protections		Metering
•	Overcurrent protections	•	
•	Earthfault protection	•	kW



	Short circuit protection	•	kWh
	Winding temp trip (for both dry type and oil filled)	•	Current – on all the three phases
	Buchholz relay (for oil filled)	•	
	Oil Temperature trip for oil filled transformer.	•	
	PRV, MOG	•	

(f) Line VT Feeders

Protections

Metering

- | | |
|---|--|
| <ul style="list-style-type: none"> • Voltage supervision | <ul style="list-style-type: none"> • Voltage – phase to phase(all the three phases), phase to neutral |
|---|--|

17. INTERNAL CONTROL WIRING

- 17.1. Control wiring by 1100V grade PVC insulated single core stranded copper wire of minimum cross section 1.5 sq.mm
- 17.2. Flexible wire of 4 sq.mm or 2 x 2.5 sq.mm will be used from CT chamber to relay chamber and will have protection against heat & mechanical damage due to flash over. Use of heat proof sleeves and rigid conduit will be made to run the control wires from back to front.
- 17.3. Flexible wires will be protected against mechanical damage for wiring to door mounted devices.
- 17.4. Wires identified at each end will have T type ferrules. These will be firmly located so that these do not move.
- 17.5. All connections external to a feeder and all the auxiliary contacts of the HV breaker and at least 1 NO + 1 NC spare contacts of the relays will be brought to terminal blocks.
- 17.6. Interconnection between panels of adjacent shipping sections to be brought out to a separate terminal block.
- 17.7. Control wires will be run in earthed metallic flexible conduits when laid in HV bus chamber.



17.8. Not more than two connections on any one terminal.

18. **EXTERNAL TERMINATION**

- 18.1.
- a) Control terminations
 - b) 1100 V grade multi-way open type terminal blocks will be of non-tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
 - c) All terminals going out of the switchboard will be brought to a separate terminal board marked “External Termination”. These will be easily accessible.
 - d) External terminal block will be of minimum rating 10 amps and suitable to receive two numbers 2.5 sq.mm copper conductor and will preferably be of cage clamp type.
 - e) For CT wiring, stud type terminals will be provided. CT wiring will be with 4.0 sq.mm wire and CT terminals will have provision for shorting the CTs.
 - f) 20% spare terminals in each control terminal block will be provided.

18.2. Power terminations

- a) Suitable for accepting cable/ bus trunking as specified.
- b) Sufficient space and support arrangement inside each panel to accommodate HT cable termination kits and sealing kits suitable for the size and number of XLPE, Aluminium cables to be terminated.
- c) Dummy panels to be provided adjacent to the switch panel where the required number of cable termination can not be accommodated in the cabling chamber of the main panel. Rear extension not acceptable.
- d) Where more than one cable have to be terminated per unit, the arrangement will permit connection and disconnection of cables separately without disturbing other cables
- e) Cable termination accessories, suitable for the type, size and number of cables to be terminated to be supplied with the switchboard.
- f) Cable socket with all HT terminals (socket set at such an angle that cable tails can be brought up for termination with minimum bending and setting.
- g) Power cable termination facilities will be designed to facilitate easy approach to CTs.
- h) Double compression type brass cable glands and crimping type copper lugs. Amps connectors will be used for HT power cables.



Control circuit fuses

19. HRC link type confirming to IS 9224.

20. **EARTHING DEVICES**

Earthing truck will have PT and alarm provision (separate trucks will be provided for feeder and bus earthing through bus PT panel in each switchboard.) 2 Nos. earthing truck for feeder earthing and 1 no. for bus bar earthing will be provided separately for station and each unit. It will not be possible to use bus earthing truck for feeder earthing and vice-versa. Rating of earthing device will be in line with associated board.

21. **PROTECTIVE EARTHING**

- a) Continuous earth bus of minimum size 50 x 6 mm copper or equivalent aluminium or galvanized steel section, designed to carry the peak short circuit and short time fault current as specified will be provided at the bottom extending throughout the length of the board bolted/brazed to the frame work of each panel with an earthing terminal at each end for terminating external earth conductor.
- b) Vertical earth bus for earthing individual functional units.
- c) All non-current carrying metal work including metallic cases of instruments and other panel mounted components will be effectively bonded to the earth bus.
- d) Hinged doors will be earthed through flexible earthing braid.
- e) Looping of earth connection resulting in loss of earth connection to other devices when the loop is broken is not permitted.
- f) Withdrawable units will be provided with self aligning spring loaded silver plated copper scrapping earth contacts of make before break type ensuring earth continuity from service to the test position.

22. **TEST AND MAINTENANCE EQUIPMENT**

Each board to be supplied with



- 1 set of test plugs.
- 3 common transport trolley for interchanging withdraw-able units, height of the trolley lifting arm adjustable for raising/ lowering the units.
- Any other special purpose tools for maintenance.
- For each HT switchgear room, one no. suitable trolley shall be provided so that person can stand on trolley safely for accessing parts of switchgear which are at height.

23. TESTS AND TEST REPORTS

- 23.1. The VENDOR will completely assemble, with all the associated equipment including bought out items mounted and wired and test each cubicle as per relevant standards.
- 23.2. Routine tests will be carried out on completely assembled equipment as per relevant standards.
- 23.3. Functional tests will be carried out to demonstrate the specified control and interlocks.
- 23.4. Copies of the test certificates for all bought out items will be submitted for the Owner's approval before despatch of the switchgear.
- 23.5. Oscillographic test records for closing and tripping timings of the breakers will also be furnished.
- 23.6. Type test of Seismic test shall be carried out as per relevant standards.
- 23.7. Type test certificates for similar equipment supplied by the bidder will be submitted. In case type test certificate for similar equipment is not available, the same will be conducted in presence of Owner or his representative if Owner so desires. However, Heat run test (Temperature rise test) will be conducted in one of each rating of HT switchgear.

24. DATA TO BE FURNISHED ALONG WITH BID

- 24.1. Experience list for the make and type of 6.6 kV breakers offered.
- 24.2. Descriptive literature on the circuit breaker and accessories.
- 24.3. Descriptive literature and application notes on the Numerical relays.
- 24.4. Type test certificates for the breakers, switchboards.

TECHNICAL DATA SHEET FOR 6.6 KV HT SWITCHGEAR

SLNo	Description	Requirements



(a)	Nominal System Voltage, Phases & frequency	6600V, 3 PH, 50 Hz
(b)	System Neutral Earthing	Medium resistance earthed
(c)	Material of bus bars	Aluminium
(d)	Heat shrinkable PVC sleeves for bus bars	Required.
(e)	Thickness of sheet steel enclosures, doors & covers	Minimum 1.6 mm for non-load bearing members Minimum 2 mm for load bearing members
(f)	Degree of protection	As per Spec
(g)	Current transformer details	
	(i) Type	Cast resin bar primary
	(ii) Class of Insulation	Class F
(h)	Voltage transformer details	
	(i) Type	Cast Resin
	(ii) Rated Voltage – Primary	$6600 / \sqrt{3} \text{ V}$
	- Secondary	$110 / \sqrt{3} \text{ V}$
	(iii) Rated Voltage Factor	1.2 Continuous
	(iv) Class of insulation	F
(i)	<u>Meters</u> (If provided separately)	
	(i) Accuracy Class	0.2/ 0.5S as specified in write-up
1.0	VACUUM / SF6 CIRCUIT BREAKER	DETAILS
1.1	Type of circuit breaker	Vacuum circuit breaker (Trip free) / SF6 circuit breaker
1.2	Type of execution	Indoor
1.3	Rated voltage	7.2 kV
1.4	Rated frequency	50 Hz
1.5	Number of poles	Three
1.6	Rated normal current	*
1.7	Reference standard	IEC-56, IS-2516, IS-13118

1.8	Draw out / Non-draw out type	Draw out type
1.9	Rated insulation level	
	i) One minute power frequency withstand voltage	20kV(RMS)
	ii) 1.2/50 μ s lightning impulse withstand voltage	60kV (peak)
1.10	Maximum temperature rise when carrying rated current	Within limits as per IEC-56
1.11	Short time current rating	40 kA for 1 secs
1.12	Symmetrical breaking current	40 kA
1.13	Making current	100 KA (peak)
1.14	No. of breaks per phase	One
1.15	Rated operating sequence	O-3 min-CO-3min-CO
1.16	Operating timings	
	i) Closing time	DDE
	ii) Tripping time	DDE
2.0	OPERATING MECHANISM DETAILS	
2.1	Type of operating mechanism	Stored energy type. Motor operated spring charging
2.2	Operating voltage of the motor	220 V DC
2.3	Type of spring charging motor	DC
2.4	Permissible percentage variation in operating voltage of the motor	85% to 110%
2.5	Class of insulation	Class-B
2.6	Over load and short circuit protection	To be provided
2.7	Electrical & Manual close / trip facility	To be provided

2.8	Provision for charging of the closing spring immediately after closing operation of the VCB	To be provided
2.9	Mechanical indicators for closing spring 'Charged & Released'	To be provided
2.10	Manual charging of closing spring	Should be possible using a handle
2.11	Mechanical indication for 'ON/OFF' status	To be provided
2.12	Number of auxiliary contacts	DDE
2.13	Maximum operating voltage of auxiliary contacts	250 V DC
2.14	Permissible continuous current of auxiliary contacts	10 A DC
2.15	Closing and tripping release	
	a) Operating voltage	220 V DC
	b) Permissible percentage variation in operating voltage of the coils	85%-110% for closing coil 70%-110% for tripping coil
3.0	Anti-pumping feature	To be provided
4.0	Material of support insulators for poles	Epoxy cast resin type
5.0	Minimum clearance between live parts & live parts to earth	As per IS/IEC
6.0	Surge arrester (for motor feeders)	
6.1	Type	Metal Oxide
6.2	Rating	Suitable for application
7.0	Manual spring charging handle	1 no. for each breaker
8.0	VCB/SF6 rack-in/rack-out handle	1 no. for each breaker

Microprocessor based Numerical Relay (6.6KV SYSTEM)

The Numerical Relay for 6.6KV Switchgears will comply with but not limited to the following technical requirements.

1	Purpose	Protection, Metering and Monitoring of Incomer, Tie/Board, Motor and Transformer feeders.
2	Auxiliary Supply	220V DC
3	CT Secondary Current	1/5Amp.
4	PT Secondary Voltage	110V AC, 3 Phase
5	Ambient Temperature	50°C
6	Communication	Compatible with DCS system through suitable connectivity (OPC link) to be decided during detail engineering.
7	Input & Output	Incomer and Bus coupler Numerical relays shall have minimum 16 opto inputs. To be finalized during detail engineering.
8	Metering	Instantaneous and Integrated values as per clause 17.0.
9	Protection	Complete protection for Incomer, Tie/Board, Motor and Transformer feeders as per clause 17.0.
10	Monitoring	Self-diagnostic facility.
11	Facility to be made available in the Numerical relay.	• Provision for synchronizing with GPS clock • Disturbance recording function • Programming keys for complete access with out computer (built in). • Provision for external programming unit through suitable software and communication ports. • Display unit. • Read/Write set points.



		• Current & Voltage actual values and any other analog measurement. • ON/OFF/TRIP indication. • Event recording with Pre-trip data with starting characteristics. • Statistical data. • Output relays. • Tamper proof security system
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4.3. TECHNICAL SPECIFICATIONS FOR 6.6 KV / 0.415 KV SERVICE TRANSFORMER

1. SCOPE

This specification covers design, manufacture, inspection & performance testing at manufacturer's works, delivery for site, including packing, forwarding, loading, transportation to site, unloading at site, storage, erection, testing and commissioning of the following transformers and accessories as detailed below

GENERAL

- 1.1.** Two (02) numbers of service transformers of rating 1.6 MVA / 2 MVA (rating shall be decided based on the geographical location of loads). The transformers shall generally comply with specific requirements as follows:
- 1.2.** The service transformers catering to LT switchgears shall be Outdoor, two winding, 3 phase, 50 Hz, Auxiliary Transformers rated as per load requirement, 6.6 / 0.433 kV, * % impedance, ONAN cooled, connected in Dyn11, with Off-load circuit taps on HV side with a range of (+) 10% to (-) 10% in steps of 2.5%.
- 1.3.** Each service transformer shall be rated for 2X100% load and also standby service transformer with 100% load capacity.
- 1.4.** The impedance of the transformers shall be chosen such that the fault level on the switchgear do not exceed 50 kA including the motor contributions and also voltage dip while starting any auxiliary does not exceed the limit acceptable for the equipment concerned but not exceeding 15%. Withstand fault capacity shall be for 3 sec.
- 1.5.** The transformer cubicle shall be located just outside the switchgear building and LV side shall be connected with solid bar connections through Cables. The HV connections shall be through cables. In case of single core cable termination, gland plate shall be of aluminium.



- 1.6.** Transformer shall operate without injurious heating, at rated MVA at any voltage within 110% of rated voltage of that particular tap.
- 1.7.** The transformer shall be rated to deliver rated MVA continuously even at the lowest tap without exceeding specified temperature rise.
- 1.8.** Transformers shall be capable of delivering the rated current, at a voltage equals to 115% of rated voltage without exceeding rated temperature rise.
- 1.9.** The transformers shall be designed for over fluxing capabilities of 110% continuous, 125% for 01 min. and 140% for 05 seconds.
- 1.10.** Transformer shall operate below the knee of the saturation curve at 110% voltage to preclude ferro-resonance and non-linear oscillations.
- 1.11.** All transformers shall be designed to limit the maximum flux density of any part of the core or yokes to 1.65 T at 100% voltage and 1.81 T at 110% voltage.
- 1.12.** Transformers efficiency shall be maximum at 40% of load.
- 1.13.** Transformers and accessories shall be designed for fault levels indicated in 6.6 KV and 415V switchgear specification. Dynamic ability and thermal ability to withstand the short circuit force shall be demonstrated by tests / calculations.
- 1.14.** Every care shall be taken to ensure that the design and manufacture of all transformers shall be such as to reduce noise and vibration to the level obtained in good modern practice. The BIDDER shall ensure that the noise level shall be restricted as per NEMA TR 1.
- 1.15.** The transformers shall be designed with particular attention to suppression harmonic voltage, especially third and fifth, so as to eliminate wave form distortion.
- 1.16.** The following minimum protections shall be provided for all the transformers. Separate potential free Alarm and Trip contacts shall be provided for each of these protections in transformer marshalling box.
 - (a) Buchholz Relay
 - (b) Winding Temperature High on both HV & LV winding
 - (c) Oil Temperature High
 - (d) Oil level low
 - (e) Pressure Relief Device
- 1.17.** Insulators used for bushings shall be with 25 mm/kV creepage distance
- 1.18.** The thermal ability to withstand short circuit shall be demonstrated by the BIDDER by calculations.
- 1.19.** Service transformer for lignite handling system shall be designed considering two stream operation.



2. MVA RATING

Each transformer shall be rated to take care of the entire load on the respective switchgear considering the outage of the other transformer. An appropriate diversity factor with a minimum of 0.9 for continuously running loads and 0.2 for intermittent loads like cranes, plug points, sump pumps, elevator etc., shall be considered. The rating established shall be taken into account, load variations during the course of engineering. Due consideration for reduction in capacity due to transformer regulation shall be given. Spare capacity of at least 10% shall be available in each transformer at the time of handing over the plant.

3. SPECIFIC REQUIREMENTS

The transformer shall generally comply with all following specific requirements.

- (a) The tank cover shall be conventional one with bolted joint at the top
- (b) The transformers shall be provided with detachable built on radiators of adequate number.
- (c) Off-circuit tap changers with lockable operating handle and mechanical tap position indicator shall be provided.
- (d) Pressure relief device shall be provided
- (e) Conservator need not be sealed expansion type.
- (f) The wheels shall be flat roller type
- (g) The transformer shall be suitable for cable connection for HV and LV side.
- (h) The neutral of the LV side of the transformer shall be brought out in a separate cable and connected to NGR of suitable rating.
- (i) OTI/WTI/PRD/MOG etc... Transformer mounted protective devices shall be provided and wiring from all devices mounted on transformer such as PRD, OTI, WTI etc. shall be brought to one terminal box with cables for connection to plant protection and controls. The cables should not touch transformer body to avoid heating.
- (j) The HV and LV winding of all transformers shall be brought out through suitably related bushing mounted on non magnetic material in separate air insulated cable box with disconnecting chambers. The cable box shall also be provided with facility for supporting from ground.
- (k) Necessary lifting lugs, jacking pads, and pulling eyes shall be provided capable of lifting and skidding of transformers without removing oil.



- (l) Each radiator bank shall be provided independently mounted with inlet and out let valves to enable replacement of radiator with transformer in service.
- (m) Transformer shall be capable of being used with any make of transformer oil complying IS 335.
- (n) The rating and nameplate shall contain all details as per IS 2026. In addition, following details shall also be included.
 - (a) Connection diagram showing internal connections.
 - (b) Connection type.
 - (c) Temperature rise
 - (d) Insulation level of windings
 - (e) Transportation weight.
 - (f) Untanking weight.
 - (g) Core and winding weight.
 - (h) Table showing tapping voltage, tapping current, Taping power for each winding.
- (i) Values of short circuit impedance on extreme tapping and on principle tapping and an indication of the winding to which impedance is related.
- (o) Transformers shall be provided with oil conservator of sufficient volume to maintain the oil seal from the minimum ambient temperature of –5 deg up to an oil temperature of 105 deg. With oil level varying within minimum and maximum oil levels. The conservator shall be provided with filing plug, drain valve, bolted cover at one end for cleaning, valves for shutting off oil to transformer, breather and bucholtz relay.
- (p) Suitable hydraulic jacks (synchronous) 04 nos. for lifting the transformer shall be supplied.
- (q) For all transformers, the conventional diaphragm type of explosion vent shall be provided. In addition to the explosion vent, the PRV shall be provided for transformers rated 2 MVA and above which shall be of sufficient size for rapid release of any pressure that may be generated within the tank and which may result in damage of the equipment. An extension pipe shall be fitted above the device such as to direct the major flow of ejected oil down wards and shall be fitted so as to permit its removal without the disturbing the device or its flange fixings.
- (r) A double float type buchholz relay as per IS: 3637 shall be provided for oil cooler transformers.
- (s) Valves shall be of gun metal / cast steel up to 50 mm size and of cast iron bodies with gunmetal fittings for sizes above 50 mm.



4. CONSTRUCTIONAL FEATURES

- 4.1.** The construction of the transformer and location of the accessories like CTs, lower ends of bushings, terminals, tap changers, etc. shall be such as to afford easy access and permit replacement of auxiliaries without removing the tank cover.
- 4.2.** Instruments and wiring for all equipment especially those in marshalling boxes shall be completely accessible.
- 4.3.** The magnetic circuit shall be constructed from high grade cold rolled non-ageing grain oriented silicon steel laminations
- 4.4.** Inspection manhole (s) with cover (s) on the top cover of the transformer.
- 4.5.** Lifting lugs or eyes for lifting of fully assembled transformer by crane.
- 4.6.** Earthing pads: Two earthing pads of copper or other non-corrodible material shall be welded at the bottom corners of the transformer tank and supplied with clamp type terminals suitable for the OWNER'S earthing conductors. Suitable earthing terminals on cable boxes and separately mounted radiator banks shall also be provided.
- 4.7.** The 6.6kV HV side Auxiliary transformer shall be suitable for Cable Box connection and 0.433kV LV side shall be suitable for Cable connection.
- 4.8.** BIDDER shall submit CT sizing calculations for all the CTs, which shall be subject to OWNER'S approval.
- 4.9.** All motors, local instruments, protective devices and devices for remote indication shall be wired up to the terminal blocks of local control cabinets / marshalling boxes along with all necessary cable glands and lugs.
- 4.10.** Anti Earthquake clamping device shall be provided to keep the transformer from moving during an earthquake, for all transformers. The clamping device shall be suitable to be fixed to the foundation.
- 4.11.** The transformer base shall be designed to permit skidding of the complete transformer unit in any direction, when using plates or rails. The under base shall be detachable unless transport facilities permit a fixed base. Pulling eyes shall be provided for moving the transformer in either direction.
- 4.12.** The material used for gaskets shall be cork-neoprene or approved equivalent. Gasketed joints for tank and manhole covers, bushings and other bolted attachments shall be so designed that the gasket will not be exposed to the weather.
- 4.13.** All transformers shall be provided with Two (2) nos. filter valves of 50mm size on diagonally opposite corners on the tank.
- 4.14.** The transformer shall also be furnished with the following non-corrodible plates, indelibly marked, showing:



- 4.15.** Location and function of all valves and plugs and indication of the maintenance instrument reference for applying vacuum of drying and oil filling.
- 4.16.** Connection diagram.
- 4.17.** To facilitate easy untanking of transformer / maintenance of equipment during overhaul, local marshalling boxes shall be so located as to require minimum disconnection during equipment maintenance / movement.
- 4.18.** Boltless type core construction shall be adopted for all the transformers. All internal metal parts of the transformer, with the exception of individual laminations and clamping plates/channels shall be earthed.

5. MATERIALS OF CONSTRUCTION AND DESIGN :-

5.1. CORE :-

Core shall be constructed with high-grade cold rolled non-ageing grain oriented silicon steel. Each lamination shall have insulated coating. The insulated structure for core to bolts and core to clamp plates shall withstand 2.00KV for 01 minute. The core clamping structure shall be designed to minimise eddy current losses. The core shall be provided with lugs for lifting of core with coils. The core and coil assembly shall be rigidly fixed to avoid their shifting during transport or short circuit.

5.2. WINDING:-

Winding shall be of copper unless and otherwise specified. Permanent current carrying connection in the winding shall be brazed or welded. The coils shall be properly supported and shall be subjected to seasoning process so that further shrinkage should not occur during service.

5.3. TANK:-

The tank shall be made from good commercial grade low carbon steel and shall be of welded constructions with suitable lugs and bosses for lifting and shifting. Tank together with accessories shall be designed to withstand full vacuum of 760mm of HG and Internal gas pressure of 0.35 KG/CM² with oil at working level. Top cover shall be bolted type to remove the core and winding at site. Manholes with bolted covers shall be provided in the top / side of transformer for access to lower end of bushings, tap changers and to permit replacement of auxiliaries without removal of top covers. All transformers shall be provided with sloping tank covers. The sloping tank covers shall have skid rings (6 mm x 18 mm steel bars) welded on them to prevent workmen from slipping off. They shall be installed such that they do not trap water.

Adequate space shall be provided at bottom for collection of sediments. At the bottom, wheels shall be provided for skidding with pulling eyes. All the gasket shall be of cork neoprene or better type and all gasketed joints shall be so arranged that gaskets will not be exposed to weather. Valves of forged carbon steel up to 50mm and of gunmetal or of cast iron bodies with gun metal fittings above 50mm shall be provided. Valves for drain, filtration oil sampling, vacuum pulling and radiator isolation shall be provided with adequate size.

5.4. BUSHINGS :-

All the bushing shall be of porcelain type. Bushing rated for 400A and above shall have non-ferrous flange and hardware.

- 5.3 Cooler control cabinets / marshalling boxes shall be weatherproof type with IP-55 degree of Ingress Protection.

5.5. ENCLOSURE

The encapsulated cast resin transformer will be housed in naturally ventilated floor mounted cubicle with louvers backed by SS wire mesh. Degree of protection for enclosure will be at least IP 32.

Protective housing made of sheet steel of minimum 2 mm thick conforming to IP32 will be provided to prevent contact with live parts. Enclosure will have ventilating openings provided with wire mesh screens and will be supplied with suitable lifting lugs.

The enclosure will be adequately reinforced to ensure rigidity so as to permit transportation of transformer within enclosure.

Double leaf access with safety limit switch will be provided with concealed hinge and neoprene gaskets for easy access to HV links and also for withdrawal of core and coil assembly if required.

Enclosure will be provided with lifting lug and grounding terminals. Further the enclosure door will have locking provision.

Necessary cubicle illumination will be provided in the enclosure.

5.6. CORE AND COILS

The transformers may be 3 phase core type. The core will be built up with high grade, non aging, low loss, high permeability grain oriented cold rolled silicon steel laminations specially suitable for core material. Laminations will be annealed in a non-oxidising atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets after the cutting and punching operations.



CRGO sheets will be coated with Insulation varnish. Insulation will be able to withstand annealing temperature as high as 850 deg. C and will reduce eddy current to minimum.

- a) The coils will be manufactured from electrolytic copper conductor of high proof stress with more numbers of radial supports and fully insulated for rated voltage. For encapsulated design, HV & LV coils will be separately encapsulated under vacuum in cast resin compound.
- b) The insulating material will conform to class F. Coils will be so insulated that impulse and power frequency voltage stresses are minimum and to withstand power frequency voltage stresses and to withstand even the severest of temperature fluctuation.
- c) Flux density at normal over voltage or frequency will be such that under 10% overvoltage condition it will not exceed 1.9 tesla.
- d) Coil assembly will be suitably supported between adjacent sections by insulating spacers and barriers. Bracing and other insulation used in assembly of the winding will be arranged to ensure a free circulation of the air and to reduce the hot spot of the winding. Permanent current carrying joints in winding and leads will be brazed.
- e) All leads from the windings to the terminal board and bushings will be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube will be used where practicable.
- f) The core and coil assembly will be securely fixed in position so that no shifting or deformation occurs during movement of transformer under short circuit stresses, switching or other transients.
- g) The transformer with core coil assembly will be provided with plain bi-directional rollers and clamps/accessories for fixing the transformer. The wheels will facilitate the movement of transformer for taking in/out of the cubicle.

5.7. TAPPINGS

- a) Off-circuit taps as specified will be provided on the high voltage winding.
- b) The transformer will be capable of operation at its rated KVA on any tap provided the voltage doesn't vary by more than +/- 10% of the rated voltage corresponding to the tap.

5.8. OFF CIRCUIT TAP CHANGER



The off circuit tap changing will be effected by change of links. Arrangement will be such that the contacts are correctly engaged. A warning plate indicating that link will be operated only when the transformer is deenergised will be provided.

5.9. TERMINAL ARRANGEMENTS

- a) Terminals for bus duct connection (if provided) will be through extended busbars.
- b) Cable end box will be self supporting, weatherproof, air filled type with sufficient space inside for termination and connection of cables.
- c) Cable end box will be furnished complete with removable gland plate, double compression brass glands, tinned copper lugs, armour clamps and necessary hardware.
- d) In general, the arrangement will be such as to permit removal of the transformer without dismantling the cable installation.
- e) A separate LV neutral bushing will be provided for connection to station ground mat (50 x 10 mm) GI flat.
- f) Vector group forming links will be provided on transformer assembly.

5.10. MARSHALLING BOX

- a) For each transformer, the marshalling box will be of sheet steel IP55. The box will be located directly on the outside face of the enclosure at suitable height.
- b) All terminal blocks for cable connection will be located in this box. The terminal blocks will be ELMEX or approved equal. It will have stud type terminals, CT wiring with 2.5 mm² wire and CT terminals will have provision for shorting the CTs.
- c) The marshalling box will be provided with removable cable gland plate with cable glands.

5.11. WIRING

- a) All control, alarm and indication devices provided in the Transformer will be wired upto terminal blocks.
- b) Wiring will be done with 19//0.005inch PTFE cable in conduit.will. Not more than two wires will be connected to a terminal. 10% spare terminals will be provided.

5.12. GROUNDING

- a) All metal parts of the transformer with the exception of individual core laminations, core bolts, and clamping plates will be maintained at fixed potential by earthing.



- b) LV neutral will be suitably earthed to two different neutral earth pits through separate earth flats of suitable size with link.
- c) Grounding bus will be provided with two bolt drilling with GI bolts and nuts at each end to receive 50 x 10 mm GI flats.
- d) Two tinned copper earthing terminals will be provided.

5.13. PAINTING

- a) All steel surfaces will be thoroughly cleaned by sand blasting or chemicals agents, as required to produce a smooth surface free of scales, grease and rust.
- b) The external surfaces after cleaning will be given a coat of high quality redoxide or yellow chromate primer followed by filler coats.
- c) The transformer coil assembly will be finished with two coats of post office red colour synthetic enamel paint.
- d) The enclosure will be finished with two coats of synthetic enamel paint shade 631 of IS 5.
- e) If it is considered necessary, the transformer may be given a further coating at site. The Bidder will therefore indicate the type and quality of the paint with full specification for this purpose.

6. TESTS

Valid type test certificate shall be submitted. If valid type test certificate is not available or type test report more than five year old than type test shall be carried out on each type of transformer.

Routine test as per IS 2026 shall be conducted on each transformer and shall be witnessed by OWNER.

In addition to all routine test as per IS 2026, the following tests shall be conducted on all transformer of each type and size.

- (a) Heat run test with dissolved gas analysis before and after
- (b) Measurement of losses and efficiency.
- (c) Oil leakage test – 12 hours.
- (d) Impedance voltage measured at principal and at all the taps.
- e) Magnetic balance test.
- f) Measurement of tan delta and capacitance of each winding and bushing.
- g) Measurement of zero sequence impedance.
- h) Measurement of harmonics of no load current.



Certified copies of test certificates of all Type tests and Special tests on similar type, design and rating of transformers covered in this specification conducted within last five years from the date of submission of Bid shall be furnished to the OWNER for review and approval. In case the type test reports are not found to be meeting the specification requirements, the BIDDER shall conduct all such tests free of cost to the OWNER and submit the reports for OWNER'S review and approval. Reports of the following tests shall also be submitted.

- (a) Impulse test on all three legs of HV & LV windings including chopped wave test.
- (b) Vacuum withstand and deflection measurement on tank.
- (c) Pressure test on tank with deflection measurement.
- (d) Determination of cooler losses.
- (e) Partial discharge test.
- (f) Pressure test on PRD.

In case the BIDDER is unable to produce any of the test reports, he shall successfully conduct those tests without cost implication to the Owner.

All auxiliary equipments shall be tested as per the relevant standards. Test certificates shall be submitted for all bought out items. High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

Test results shall be corrected to a reference temperature of 75°C. The BIDDER shall maintain all test and calibration records in approved formats, and these shall be countersigned by authorized quality control personnel of the BIDDER supervising these works.

Site tests shall include all tests to be carried out at site on various equipments. They shall include but not be limited to calibration tests, configuration tests and commissioning tests. The BIDDER shall be responsible for all site/commissioning tests. All necessary testing equipment required for testing and commissioning shall be arranged by the BIDDER

7. TRANSPORTATION

The transformers shall be transported without oil but with the tank filled with nitrogen under pressure complete with gas cylinder, reducer connection and pressure gauge. The accessories shall become the property of the OWNER. Required quantity of oil drums plus 10% extra shall be supplied separately in non-returnable drums, effectively sealed to prevent entry of moisture. Supply of transformer oil shall precede the supply of transformer so as to facilitate filling of the transformer bank with tested oil, well before commissioning, to prevent absorption of outside moisture by the windings.



8. SPARES

- 8.1.** The BIDDER shall submit a list of recommended spares required for initial FIVE (5) years of trouble-free operation.
- 8.2.** The following spares shall be necessarily included by the BIDDER in his offer.
- (a) One (1) no. complete set of gaskets for each type of transformer.
 - (b) One (1) no. Dial type thermometer for each type of transformer.
 - (c) One (1) no. Oil level gauge for each type of transformer.
 - (d) One (1) no. Silica-gel breather for each type of transformer.
 - (e) One (1) no. Pressure relief device for each type of transformer.
 - (f) One (1) set of valves of each type and size for each type of transformer.
 - (g) One set of buchholz relay of each type and size for each type of transformer
 - (h) One no. WTI instrument for each type, rating and size of transformer
 - (i) One no. OTI instrument for each type, rating and size of transformer

The final spare list shall be decided by the OWNER in consultation with the BIDDER.

The bidder shall supply these spares along with the transformers.

SERVICE TRANSFORMERS TECHNICAL SPECIFICATIONS

TECHNICAL REQUIREMENTS

The service transformers shall comply with the particulars indicated below and BIDDER shall furnish the details in respective column given below (To be separately submitted for transformers of different ratings and type)

SL. NO.	DESCRIPTION	UNIT	SPECIFICATION REQUIREMENTS	BIDDER'S DATA
1.0	Transformer applications		Service Transformer	
2.0	Type & make		Outdoor, two winding, 3 phase.	

3.0	Applicable standard		IS : 2026	
4.0	Quantity		02 (Two)	
5.0	Full load rating	MVA	1.6 / 02 MVA	
6.0	Rating no load voltage HV/LV	kV	6.6 / 0.433	
7.0	Impedance value	%	*	
8.0	Rated frequency	Hz	50	
9.0	Winding connection of different windings and vector group		Dyn11(Typical)	
10.0	System earthing (a) HV (b) LV		Non-Effectively Effectively	
11.0	Type of tap changer off circuit/on load		Off Load	
12.0	Tapping range and number of steps		Refer Clause 1.2	
13.0	Type of voltage variation (CFVV/VFVV/CbVV)		CFVV	
14.0	Overfluxing capability		110% continuous	
15.0	Winding insulation type			
15.1	HV		Uniform	
15.2	LV		Uniform	
15.3	Impulse withstand voltage of winding HV/LV	kVp	As per IS	
16.0	Power frequency withstand voltage of winding HV/LV	kV/rms	As per IS	
17.0	Maximum temperature rise at full load with 100% coolers : (a) Oil (b) Winding	°C °C	50 55	
18.0	Bushing particulars.			
18.1	Applicable standard for bushing		IS-2099	



18.2	Clearance in air between phases	mm	HV – 90 (P-P)(P-E) LV – 25.4 (P-P), 19.0 (P-E)	
18.3	Creepage distance	mm	* (Min 25mm/kV)	
19.0	No load loss	kW	*	
20.0	Load loss	kW	*	
21.0	Guaranteed efficiency at full load	%	*	
22.0	Total estimated weight	Kgs	*	
23.0	Guaranteed No load current			
	When excited from LV side at 100% and 110% rated voltage	Amps	**	
24.0	Max. Flux density when rated and 110% rated voltage	Wb/m ²	**	
25.0	SYSTEM FAULT LEVEL	KA	40KA Sym. at 6600V at 1 sec 50kA Sym. at 415V at 1 sec	
26.0	Weight			
26.1	Core	kg	**	
26.2	Net copper wt. HV/LV	kg	**	
26.3	Oil	kg	**	
26.4	Tank, coolers & fittings	kg	**	
26.5	Total	kg	**	
26.6	Untanking weight	kg	**	

NOTE : ‘*’ Information shall be filled furnished by BIDDER along with offer.

‘**’ BIDDER shall furnish these details after award of contract.

4.4. TECHNICAL SPECIFICATIONS FOR MOTORS

1. AC MOTORS



- 1.1.** All motors above 175 kW shall be suitable for 6.6kV, 3 phase, 50Hz. Motors rated up to and including 175 kW shall be suitable for 415V, 3 phase, 50 Hz power supply. Continuous running motors shall be premium energy efficient motor with maximum efficiency at duty point.

All HT motor & LT motor(≥ 55 KW) multifunction meter (Secure Elite 440) shall be provided.

- 1.2.** All LT motors shall be energy efficient class – I in line with IEEMA – EFF-1 except continuous running motors shall be premium energy efficient motor with maximum efficiency at duty point.
- 1.3.** Variable frequency controller (VFD) shall be provided for LT motors, as per system requirement with due approval from Owner / Engineer, which require speed control and load variations under various operating conditions of unit.
- 1.4.** The motor rating shall be arrived at considering 20% margin over the duty point input or 20% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency. Motors shall be capable of starting and accelerating the load with the applicable method of starting without exceeding acceptable winding temperatures when supply voltage is 80% of the rated voltage for HT motors and 85% for LV motors. HT motors shall also be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 min. commencing from hot condition.



- 1.5.** Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under supply conditions I as indicated below.

	<u>Supply Condition</u>	
	I	II
(a) Variation in supply voltage		
from rated voltage	±10%	±10%
(b) Variation in supply frequency		
from rated frequency	±3% to -5%	±5%
(c) Combined voltage and frequency variation	+10% to -10%	

- 1.6.** Motors when started with the driven equipment coupled shall be capable of withstanding at least two successive starts from cold conditions & one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

- 1.7.** Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of the rated voltage. If such operation is envisaged for a period of one second, the pullout torque of the motor shall be atleast 205% of full load torque. For motors with starting time up to 20 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at higher voltage limit shall be atleast 2.5 secs more than starting time.

- 1.8.** For motors with starting time more than 20 secs and up to 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at higher voltage limit shall be at least 5 secs more than starting time. For motors with starting time more than 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at higher voltage limit shall be more than starting time by at least 10% of the starting time.



- 1.9.** Motors shall withstand for 1 second the voltage and torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of the rated voltage during fast change over of buses.

- 1.10.** Locked rotor current of the HT motors rated 1500 kW and below shall be limited to 600% (inclusive of 20% tolerance) of the full load current of the motors and motor rated above 1500 kW shall be limited to 450% (inclusive of 20% tolerance) of full load current of the motor. Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of 20% tolerance. Motors rated above 1000 KW shall have insulated bearings to prevent flow of shaft currents. The motors shall be suitable for bus transfer schemes provided on 6.6kV, 415V systems without any injurious effect on its life.

The power factor of HT and LT motors shall be equal to or better than the values indicated below:

HT M HT HT Motors : 0.9

LT Motors (Above 37 kW) : 0.88

All HT motors shall have minimum 92% efficiency at full load conditions.

Motors shall be designed to withstand at least 5% harmonics in the supply voltage.

- 1.11.** The degree of protection for the motor enclosure (including terminal box) shall be IP-55 for outdoor and IP-54 indoor. For single core cable termination, gland plates shall be of non-magnetic material. All motors located in hazardous area shall have flame proof design.

- 1.12.** All HT motors shall be provided with vibration pads for mounting vibration detectors. Vibration monitoring devices shall be provided on DE and NDE side in X & Y direction with remote DCS monitoring, alarms and tripping.

For HT drives, current signal to DCS for each HT drives shall be provided

LT motors, current signals to DCS for LT drives of rating ≥ 55 KW rating shall be provided.

Emergency system – current signal and group alarm for each drive used for any emergency system

The analog / digital signals shall be integrated hardwired to DCS / ECP. (Group alarm means signals for respective systems to be grouped in a common window for showing the alarm in DCS / ECP)

- 1.13.** Surge protection shall be provided for all HT motors.



- 1.14.** The terminal box of motor shall be of suitable size, suitable to terminate and maintain the cables easily. Terminal box shall be suitable to rotate at 90 degrees. Contractor to ensure the terminal box dimensions are specifically worked-out to accommodate the selected cable size and those details to be indicated in motor GA drawings.
- 1.15.** Double compression type brass cable glands and crimping type copper lugs shall be provided for termination. Amp type connection shall be used for HT power cables and cage clamp type connectors shall be used for LT control cables. Amp type lugs shall be used for LT motors of rating 110 kW and above.
- 1.16.** The maximum double amplitude vibrations for motors up to 1500 rpm shall be 25 microns and 15 microns up to 3000 rpm. For 415V motors, maximum double amplitude vibrations up to 1500 rpm shall be 40 microns and 15 microns up to 3000 rpm.
- 1.17.** Maximum noise level measured at a distance of 1.5 meter from the outer surface of the motor shall not exceed 85 db (A).
- 1.18.** Cable boxes of all HT motors shall be Phase segregated & shall be provided with quick disconnecting type terminal connectors to facilitate easy disconnection and removal of the motors without requiring unsealing or otherwise disturbing the external cable connections and leaving the phase segregated terminal box intact.
- 1.19.** All HT AC motors shall have BIL of 31 kV (Peak) 1.2 / 50 microsecond wave and shall withstand a power frequency voltage of 14.2 kV (rms) for one minute as per Table-1 of IEC-34-15.
- 1.20.** Motor bearing shall be insulated wherever required. For VFD motors, motor NDE bearing should be insulated type and on DE side, shaft voltage earthing assembly should be provided.
- 1.21.** All HT motors shall be with VPI insulation or better.
- 1.22.** All HT motors / LT motors 15 kW and above shall be provided with external greasing arrangement.
- 1.23.** Cooling: All motors shall be either TEFC or TETV or CACA type. For hazardous location such as fuel oil facilities area, the enclosure of motors shall have flame proof construction as per IS:2148.
- 1.24.** All HT motors / LT motors 30 kW and above shall be have a provision of space heating using 240 V AC supply and for LT motors below 30KW shall be have a provision of space heating using 24V AC through motor windings.
- 1.25.** All motors below 15 kW shall be provided with sealed 2RS bearings.



- 1.26.** Provision shall be made at DCS to monitor, integrate running hours, nos. of starts and stop recording for all motors.
- 1.27.** All LT Motors shall be Contactor for start / stop operation. SFU, Contactor & Relay. Motor => 55 KW rating shall have microprocessor based Numerical relay. Motor => 30 KW rating shall have Programmable transducers with two nos. 4-20 mA output for remote monitoring of Motor load current.
- 1.28.** Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously at a supply voltage within +10 to –15 % from motor rated voltage.
- 1.29.** Speed switches are to be provided if required. If provided, it shall be indicated out by the bidder in his offer. When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation. If the speed switch requires any auxiliary voltage, it shall be suitable for the auxiliary voltage.

2. INSULATION

- a) HT Motors shall be given power house treatment. Additional treatments to withstand heavily salt polluted or similar atmospheric conditions shall be given based on the location.
- b) LT Motors The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.
- c) Insulation of LT VFD controlled Motors shall be designed to withstand a dv/dt of 0.1 micro sec rise from 10 % to 90 % of steady voltage and a maximum peak of 1600 volts as per NEMA standard MG1 Part 31.40.4.2
- d) The insulation system shall withstand steep front impulse voltage of value given as per Table-1 of IEC-34-15 having front time of 0.2 microsecond.
- e) Class of insulation shall be Class F or better with temperature rise limited to class B.



3. TEMPERATURE RISE

- a) The temperature rises shall not exceed the values given in IS 12802. Under extremes of supply condition (clause 4.1 above), the temperature rise shall not exceed the value indicated in IS by 10°C.
- b) For motors specified for outdoor installation heating due to direct exposure to solar radiation shall be considered.
- c) HT Motors shall be provided with at least six resistance type temperature detectors for the stator winding each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected. The material of the ETD's shall be platinum. Two ETDs shall be provided for each of the motor bearing & shall be wired up to the terminal box. The temperature detectors shall be of 3 wires, duplex type.

4. Constructional features

- a) All insulated windings shall be of Copper.
- b) All HT Motors and LT Motors above 25Kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- c) Motors shall be provided with drain plugs, so located to drain water, resulting from condensation or due to other causes, from all pockets in the motor casing.

5. . BEARINGS

- 1. Unless otherwise specified in data sheet-A, motor bearings shall not be subjected to any external thrust load.
- 2. Unless otherwise specified, motor bearings shall have an estimated life of at least 40,000 hrs.
- 3. The bearings shall permit running of the motor in either direction of rotation.

HT Motor bearings

- 1. If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil & an oil level sight gauge shall be provided to show the precise oil level required for standstill and running conditions.
- 2. It shall be possible to lubricate the bearings without dismantling any part of the motor.
- 3. Each bearing shall be provided with two ETDs Each ETD shall consist of 2 potential free contacts. They shall be designed to close independently at two different temperatures - one for 'Alarm' and another for 'Trip'.



4. The contact rating of the potential free contacts shall be 1A at 240V AC & 0.1A at 220V DC. Any auxiliary supply, if required shall be indicated by the bidder.
5. The thermometers shall be located at a convenient height for easy reading and handling.
6. One bearing shall be insulated to prevent shaft currents.
7. VFD controlled Motors shall have their NDE bearings insulated to prevent motor shaft currents from entering the bearing race and motor DE side should be having shaft earthing arrangement.
8. For HT motors having shaft voltage exceeding 500mV, shall be invariably provided with NDE bearing as insulated type bearing
9. For HT motors, bearing cage shall be invariably brass cage type.

6. TERMINAL BOX

1. Separate terminal boxes shall be provided for each of the following:
 - a) Stator Leads
 - b) Rotor leads (wound motors)
 - c) Space Heaters
 - d) Temperature Detectors
2. The three phases shall be segregated by barriers of metal or fibre glass.
3. The cable box design shall be suitable for any type of cable termination kits available.
4. Unless otherwise approved, the terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees
5. Terminals shall be of stud type & the terminal box shall be complete with necessary lugs, nuts, washers.
6. When single core cables are to be used the gland plates shall be of non-magnetic material.

7. 415 V MOTORS – MINIMUM SIZES OF CABLES, STUDS, TERMINAL LUGS & TERMINAL BOXES

(TO BE PROVIDED ON MOTORS BY VENDOR)

Sl	Motor	1100V Al Conductor, armoured XLPE-FRLS
No.	Rating	Cable



	(kW)	Cores x mm ²
1.	Upto 3	3x4
2.	3.1 - 7.5	3x6
3.	7.6 - 15	3x16
4.	16 - 25	3x35
5.	26 - 40	3x70
6.	41 - 55	3x120
7.	56 - 70	3x185
8.	71 - 85	3x240
9.	86 - 110	3x400
10.	111 - 200	3x1Cx500

8.

SPACE HEATERS:

Motors shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

9.

EARTHING:

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connection of the OWNER'S earthing conductors. These earthing points shall be in addition to earthing stud provided in the terminal box.

10.

PAINTING:

All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of epoxy primer and finished with two coats of grey epoxy paint. Each coat of min 30 microns.

11.

TESTS

- a) All routine & acceptance tests as per relevant IS/IEC-34 shall be conducted on HT motors. Type test shall be carried out on one motor of each make & type and the test reports shall not be older than -5(Five) years. IF such is the case then the same type test shall be carried out

in presence of Owner / Engineer without any extra cost implication to Owner.

- b) For 415V motors and DC motors, if type test certificates are available for the same rating of the motors offered, the same shall be furnished, else they shall be conducted. However, all routine and acceptance tests shall be conducted on all 415V motors as per relevant IS/IEC standards. Efficiency and loss measurements shall be done for all LT motors as per relevant standard.
- c) The routine and acceptance tests specified in IS 9334 shall be conducted on each valve actuator. In addition to the above tests the following shall also be conducted as part of routine tests.
- d) For HT AC motors, in addition to all the tests specified above, polarisation index test shall be carried out as a routine test on each motor (the minimum value of polarisation index for all motors shall be 2 when determined according to IS: 7816).
- e) Noise level measurement test shall be conducted on one motor of each type.
- f) Dielectric tests to establish the insulation withstand level of motors as indicated above shall be performed on a sample coil (identical to those to be used in the motor quoted for) for each type of motor. These tested sample coils shall not be used in the motors to be supplied.

TECHNICAL DATA SHEET FOR MOTORS

1.10	Type of motor		*
1.11	Supply Conditions		*
	(a) Allowable variation in		*
	(i) Voltage AC/DC	%	Refer Specification
	(ii) Frequency	%	± 5
	(iii) Combined	%	10
	(b) Permissible unbalance in supply voltage		Refer Specification
1.12	Speed	rpm	*
1.13	Rated voltage		*
	HT motors		
	LT motors		
	Single phase		
1.14	Number of phase		*
1.15	Rated frequency for AC motor	Hz	50



1.16	Normal winding connection	Star / Delta	*
1.17	Method of starting AC motors DC motors		DOL (preferably) *
1.18	Temperature rise above ambient of 50 deg. by Residual method	Deg. C	Refer Specification
	Type of rotor (Slip ring/ squirrel cage)		Squirrel cage except for cranes, hoist & elevators (for small capacity cranes, hoist VFD shall be provided)
1.19	Type of duty		*
1.20	Duty designation		*
1.21	Synchronous speed a) Constant speed b) Variable speed (for VFD)		*
1.22	Starting time at specified minimum starting voltage	Sec	*
1.23	Starting torque	% of FLT	*
1.24	Pull out torque	% of FLT	*
1.25	Class of insulation		F or better
1.26	Ref. Ambient temperature	deg. C	50
1.27	Temperature rise of winding by thermometer above ambient	deg. C	Shall be limited to class B insulation
1.28	Location considered – Hazardous area division		*
1.29	Atmosphere considered- Chemical/Dusty/Salt laden		*
1.30	Type of cooling (IS: 6362) LT motors HT motors		TEFC TEFC
1.31	Degree of protection		IP55
1.32	Terminal box Short time rating a) HT for 0.25 sec b) LT for 1 sec	KA	40 (minimum)



	Dynamic rating	KA	50 (minimum) 100 (minimum)
	a) HT	KA peak	
	b) LT	KA peak	125 (minimum)
1.33	Terminal box degree of rotation	Degree	360 degree in steps of 90
1.34	Weather motor is suitable for VFD drive		*
1.35	Method of cooling in case of VFD application motor.		*
1.36	Details of bearing		*
1.37	Frame size		*
1.38	Color shade of paint		Shade 631 of IS-5
1.39	Manufacturer		*
1.40	Whether CT for differential protection required		*
1.41	Whether vibration detectors required		*
1.42	Details of winding / space heaters		*
1.43	Guaranteed Efficiency of motor		*
	a) At full load		
	b) At duty point		
	c) At no load		
1.44	Guaranteed Power factor of motor		*
	a) At full load		
	b) At duty point		
	c) At no load		
1.45	Current at		*
	a) Starting		
	b) Full load		
	c) Duty point		
	d) Full load & 70 % of rated supply voltage.		
1.46	Quantity & type of temperature detectors for all HT motors		Refer Specification
	a) Winding hot spot		
	b) Bearing		



1.47	Details of accessories a) Fans b) Temperature gauge c) Bearing d) Cooling motors e) Cooling water parameters f) Heaters g) Lube oil system details		*
	Maximum size & number of cables that can be accommodated in motor terminal box.		*
1.48	Thermal capability curve to be attached		*
1.49	Relay co-ordination guide to be attached.		*
1.50	Min. voltage required under starting conditions to accelerate driven equipment to rated speed.	Volts	*
1.51	Locked rotor current withstand time (safe stall time) at 110 % rated voltage a) At rated temp. (hot) b) When cold	Sec Sec	*
1.52	Stator thermal time constant	sec	*
1.53	Permissible no.of equally spread starts per hour a) Normal service conditions b) In quick succession with cold M/C at room temp. c) Hot restarts		*

NOTE : “*”Information shall be filled furnished by Bidder along with offer.

4.5. TECHNICAL SPECIFICATIONS FOR LOCAL CONTROL PANEL, LOCAL PUSH BUTTON STATION, MISCELLANEOUS PANEL

1. SCOPE

1.1. This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR'S / his SUB-VENDOR'S works, delivery to site and performance testing of local control panels, Local push button stations, Miscellaneous Panels/ DBs up to 415V.



- 1.2. BIDDER shall include in his scope required no. of 415V AC power supply Local control panels/ Distribution boards/Miscellaneous panels for feeding packaged auxiliary loads, etc. BIDDER shall provide one or two (depending on the criticality of the service) incomers from 415V main switchboard to feed the distribution board/local control panel. All the incoming and outgoing feeders shall be SFU controlled.

Local panel to be located outdoor in dusty environment shall be double door type.

Local control panel along with in-built starter shall be provided for all type of sump pumps in entire plant area.

In entire lignite handling system, unless otherwise specified, all local JB, local panels, local control stations etc. shall be double door type and flame proof only.

2. CODES AND STANDARDS

This design, material, construction, manufacture, inspection, testing and performance of local control panels, miscellaneous panels/ DBs (now on referred to as Control Cabinets) shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards.

3. CONSTRUCTIONAL FEATURES

- 3.1. Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof providing a degree of protection of IP 52 for indoor use and IP 54 for outdoor use. Sheet Steel used shall be cold rolled and at least 2.0mm thick and properly braced to prevent wobbling.
- 3.2. Control cabinets shall be provided with hinged door(s) with padlocking arrangement and suitable brackets/channels shall be provided for the type of mounting specified in Data Sheet A.
- 3.3. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual fuses, switches, MCBs without danger of contact with live metal.
- 3.4. All live parts shall be provided with atleast phase to phase and phase to earth clearances in air of 25 mm and 20mm respectively.
- 3.5. Adequate interior cabling space and suitable removable cable glands shall be provided. Necessary number of cable glands shall be supplied and fitted screwed-on type and made of brass.



- 3.6. Two earthing terminals shall be provided to suit the Owner's earthing conductor.
- 3.7. All sheet steel work shall be degreased, pickled, phosphated and then applied two coats of zinc chromate primer and two coats of finishing synthetic enamel paint, both inside and outside, of colour as specified. For chemical/corrosive areas epoxy paint shall be used whenever specified.

For local panel located outside, in spite of IP55 protection, canopy shall be provided to prevent dust accumulation and panel shall have double door arrangement.

The JB used in outdoor dust, lignite, ash prone areas shall be weatherproof type, sheet steel thickness of the JB shall be minimum 2 mm. Sheet steel shall be hot dip galvanised. JB shall be double door type with canopy at the top and IP protection shall be minimum IP55.

4. MAIN BUSBARS

Busbars shall be insulated and of aluminium alloy of E91E grade and shall have adequate cross-section to carry the required continuous currents such that the operating temperature of the busbars does not exceed 85°C.

5. MOTOR FEEDERS

- 5.1. Each motor to be controlled from the cabinet shall be provided with 3 pole/2 pole isolating switch, HRC fuses, contractors with thermal overload relays and other equipment required for satisfactory control of motors. When schematic drawings/bill of material is enclosed, all equipment shown shall be supplied by the VENDOR. The isolating switch and contactor shall be rated at least 20% more than the connected motor full load current.
- 5.2. Unless otherwise specified motors rated 0.5KW and above being controlled from the local control cabinet will be rated for 415V, 3 phase, 50 Hz and motors rated below 0.5 KW will be 240V, 1 phase, 50 Hz.

6. SWITCHES/ MCBS

- 6.1. Switches / MCBs / MPCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable standards.
- 6.2. The rating of switch shall be so chosen as to get complete protection by associated O/L relay or fuse under all normal/abnormal conditions such as full load, overload, locked rotor, short circuit etc. MCBs / MPCBs shall be provided with overload/short-circuit protective device.
- 6.3. It shall be the responsibility of the VENDOR to fully coordinate the overload and short circuit tripping of the MCBs / MPCBs with the downstream MCBs/fuses/motor starters, to provide satisfactory discrimination.



- 6.4. Switch handle shall have provision for locking in both fully open and fully closed positions. MCBs / MPCBs shall be provided with locking facility when called for in Data Sheet.

7. CONTACTORS

- 7.1. Contactor type motor starters shall be of the full voltage, direct-on-line, air break, single throw, electro-magnetic type unless otherwise specified. Automatic star-delta type starters shall be provided when specified.
- 7.2. Contactors shall be provided with at least 2 'NO' and 2 'NC' auxiliary contacts.
- 7.3. Contactor shall be provided with a three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated motor current.

8. FUSES

- 8.1. Fuses generally shall be of the HRC cartridge link type, mounted on plug-in type of fuse bases having a rupturing capacity of 80 kA. Fuses upto 63A may be of HRC cartridge screw-cap, D-type, having a rupturing capacity of not less than 46 kA at 440V A.C. and 16 kA at 250V D.C.
- 8.2. Fuses shall be provided with visible operation indicators to show that they have operated.
- 8.3. All accessible live connections shall be adequately shrouded, and it shall be possible to change fuses with the circuit alive, without danger of contact with live metal.

9. INSTRUMENT TRANSFORMERS

Current and voltage transformers shall be dry type. Unless otherwise specified it shall be the responsibility of the VENDOR to ensure that the class and VA burdens of the instrument transformers provided are adequate for the relays and meters connected to these. Facilities shall be provided for short circuiting and grounding the CT secondary at the terminal blocks. Test links shall be provided in the CT secondary leads to carryout current and phase angle measurement tests with CTs in service. Voltage transformers shall be provided with suitably rated primary and secondary rated fuses. The details of the instrument transformer are subject to the Owner's approval.

10. CONTROL AND AUXILIARY POWER SUPPLY

- 10.1. All AC control equipment shall be suitable for operation on 240V AC, 1 phase, 50 Hz system. This supply may be obtained from phase and neutral when 4 wire 415V main supply is available. Otherwise, or when control voltage, other than 240V is specified, a suitable transformer shall be provided. The control transformer shall be complete with isolation facilities and primary and secondary HRC fuses.

10.2. Separate circuits with switches, fuses etc. of adequate rating shall be provided for control of space heater, through thermostat and panel illumination etc.

11. RELAYS

- 11.1. Necessary auxiliary release for alarm, time-delay relays, voltage relays as required for control and protection shall be mounted inside the cabinet. Relays shall be equipped with externally reset, positive action operation indicator. Voltage relays shall have sufficient thermal capacity for continuous energization, using external resistors if necessary.
- 11.2. Auxiliary relays shall be rated to operate satisfactorily between 80% and 110% of the rated voltage.
- 11.3. Each relay shall be provided with at least two potential free contacts (1NO+1NC) for the OWNER's use.
- 11.4. Make and type of relay shall be subject to the OWNER's approval.

12. CONTROL AND SELECTOR SWITCHES

Control and selector switches shall be of the rotary type provided with properly designated escutcheon plates clearly marked to show the operating positions. Control switches shall have momentary contacts, spring return to centre, with pistol grip handle. Selector switches shall have stay put contacts with oval handles. The number of contacts and their operation in each switch shall be as indicated in control schematic (when enclosed) or shall be as per the requirements of the connected circuit. The switches shall be rated for minimum 10A at 250V A.C. and 1A inductive break at 250V D.C.

13. PUSH BUTTONS

All pushbuttons shall be of push to actuate type having 2 'NO' and 2 'NC' self reset contacts. They shall be provided with integral escutcheon plates, engraved with their functions. Pushbuttons contacts shall be rated for 10 Amps at 250V/ 110V A.C. and 1 Amp inductive breaking at 250V D.C.

In entire material handling system areas, local push button station shall be flame proof and weather proof type only.

14. INDICATING LAMPS

Indicating lamps of the Clustered Coloured LED type with coloured Lens engraved "ON", "OFF", "TRIP".

15. SPACE HEATER

Strip type space heaters of adequate capacity shall be provided inside each cabinet. Heaters shall be complete with rotary type 'ON-OFF' switch, HRC



fuse on phase or a single-pole MCB with overload and short circuit protection, link on the neutral and a thermostat to cut off the heaters at 45 Degree Celsius and shall have continuously settable range from 30 to 90 degree Celsius.

16. INTERIOR LIGHTING AND RECEPTACLE

- 16.1. Control cabinet shall be provided with a 240V, 1 phase, 50 Hz, 40W preferably fluorescent lighting fixture for interior illumination controlled by a 'ON-OFF' switch / MCBs and 240V, 1 phase, 5/15 Amp., 3 pin receptacle with Plug and Switch/MCB for Switching ON & OFF.
- 16.2. Power source for interior lighting and receptacles shall be completely independent of control power source.

17. CABINET INTERNAL WIRING

- 17.1. Control cabinet shall be supplied completely wired, ready for the OWNER'S external connections at the terminal blocks. All wiring shall be carried out with 1100V grade, PVC insulated, stranded conductors. Power circuits shall be wired with standard aluminium conductors of adequate sizes to suit the rated circuit current; the minimum size shall be 6 sq.mm. Control, alarm and indication circuits shall be wired with stranded copper conductors of sizes not smaller than 1.5 sq.mm. While C.T. circuits shall be colored wired for R Y B phases with stranded copper conductor of size, not smaller than 2.5 sq.mm.
- 17.2. Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be adequately rated for the circuit current, the minimum rating shall be 20A.

18. LOCAL PUSH BUTTON STATIONS

- 18.1. The local P.B. stations shall be metal enclosed, provided with IP-55 protection, made up of die cast aluminum or 2 mm thick sheet metal. Outdoor PB stations shall be made of FRP of standard make.
- 18.2. The P.B. station shall be suitable for wall or structure mounting, provided with labels, earthing terminals, suitable lugs glands.
- 18.3. Push buttons shall be fitted with 2 NO and 2NC contacts (1A at 250V DC and 10A at 250V/ 110V AC) with stop PB of stay put type and red in colour. Other PBs shall be green in colour.
- 18.4. PB station shall be of one of the following types
 - Type A - Three PBs Forward – Reverse – Stop lockable for reversible motors
 - Type B - Two PBs Start – Stop lockable for non-reversible motors
 - Type C - One PB Stop for emergency, mushroom type lockable

19. LABELS AND DIAGRAM PLATE

- 19.1. Every equipment mounted in the cabinet shall be provided with individual labels with equipment designation/rating. Also, the cabinet shall be provided on the front & Rear side with a non-rusting label engraved with the designation of the cabinet as furnished by the OWNER.
- 19.2. Inside the door a circuit diagram engraved on non-rusting metal / PVC shall be fixed for reference.

20. DRAWINGS AND DATA

- 20.1. As part of the proposal, the BIDDER shall furnish the following drawings and data for scrutiny.
- a) Control cabinet general arrangement drawing showing dimensioned views, cable entry location and mounting details.
 - b) Schematic wiring diagram of the control cabinet.
 - c) Bill of material listing equipment designation, make, type, rating etc. of the various equipment mounted on the control cabinet.

21. TESTS & TEST REPORTS

- 21.1. Acceptance and routine tests for all supply equipments/component parts shall be carried out as per the relevant standards for the respective equipment. These test reports and available type test reports shall be submitted to the OWNER before despatch of the equipment.
- 21.2. Control cabinet shall be subjected to following tests:
- a) High voltage test (2000 volts for 1 minute)
 - b) Megger test
 - c) Electrical control, interlock and sequential operation tests.
- 21.3. Calibration certificates. Instruments used for testing and inspection shall have valid calibration and accuracy traceable to National Standards.

22. SIREN / HOOTER PANEL

Outdoor type double door Panel for Kheraj make dynamically balanced siren / hooter of 110V AC at required locations with 110V AC control switchgears. Specifications shall be provided during detailed engineering.

23. SIGNAL POST LIGHTING PANEL

Signal post lighting with control panel (double door) at dump area on ramp shall be provided. Specifications shall be provided during detailed engineering.

TECHNICAL DATA SHEET – A

1.	GENERAL PARTICULARS	Unit	Specification
1.1.	DESIGNATION		LCP/MISC PANEL/DB
1.2.	LOCATION		INDOOR
1.3.	DESIGN AMBIENT TEMPERATURE	⁰ C	50
1.4.	TYPE OF MOUNTING		FLOOR
1.5.	CABLE ENTRY		
	A) TOP / BOTTOM		BOTTOM
	B) GLANDS / CONDUITS -SIZE		D.D.E
	C) GLANDS IF REQUIRED		YES
1.6.	OWNER'S EARTHING CONDUCTOR		
	A) MATERIAL		GS
	B) TYPE		STRIP
	C) SIZE		D.D.E
1.7.	PAINTING:		
	A) COLOUR FINISH		
	OUTSIDE		SHADE 631 OF IS 5
	INSIDE		GLOSSY WHITE
	B) EPOXY PAINT REQUIRED	Yes/No	YES, 2 COATS (Min 75 Microns)
1.8.	CONTROL SCHEME & BILL OF MATERIAL, ENCLOSED	YES. Ref .No	BIDDER TO FURNISH
	If NO, TO BE FURNISHED BY VENDOR		
2.	VOLTAGE		
2.1.	POWER DEVICES, MOTOR DRIVES, ETC.		
	A) SUPPLY VOLTAGE		415V, 3 PH/ 230V, 1 PHASE
	B) DUPLICATE FEED		*
2.2.	CONTROL VOLTAGE	V, AC, DC	110V AC
2.3.	CONTROL TRANSFORMER	REQD. NOT REQD.	REQD.



2.4.	SPACE HEATER/LIGHTING SUPPLY VOLTAGE		230V, 1PH, AC,50Hz
3.	OTHER PARTICULARS WHEN APPLICABLE		
3.1.	STARTERS TYPE	DOL/R EVY / <	DOL WHEREEVER APPLICABLE
3.2.	CONTACTOR RATED DUTY (AS PER IS:2459 & 8544)		CONT

DATASHEET – B

(Data to be furnished by Bidder)

1	Manufacturer's name		
2	Indoor/Outdoor application		
3	Thickness of sheet steel	mm	
4	Degree of protection provided (as per IS:2147 or equivalent)		
5	Bill of Material for the various equipment giving make, type, ratings etc. enclosed	Yes/No	
6	Colour of finish paint		
	a) Outside		
	b) Inside		
7	Busbars for power devices (when applicable)		
	a) Material		(PVC Insulated/Bare)
	b) Continuous current rating	A	
8	Control Wiring/Power Wiring		
	a) Material of conductor and size	Cu/Al mm ²	
	b) Conductor – solid/Stranded	-	



4.6. TECHNICAL SPECIFICATIONS FOR DC SYSTEM (BATTERY, BATTERY CHARGER & DCDB)

1. 220V DC SYSTEM

- 1.1. 220V DC power supply shall be provided as the most reliable source of power supply for control, protection, interlock and annunciation requirements of the power station during the normal running of the plant, as well as for a safe shut down at the time of the total power supply failure. ‘
- 1.2. The batteries shall be lead acid HDP / plante type and the shall be provided for the following applications.
 - a) Lignite handling system plant-1x100% float cum boost charger with 1x100% 220V DC battery shall be provided. In addition to 220V DC LHS loads.
 - b) With regards to selection of battery set between HDP or Plante, it will be subjected to approval from Owner / Owner's Engineer.
- 1.3. The following DC Distribution Boards shall be provided:
 - a) DC distribution board (One set) shall be provided, separately Lignite handling DC loads.
 - b) DCDBs shall be provided for each of the auxiliary systems, ie, LSH. Each DCDB shall have 2 x 100% incomers and a bus-coupler. However, second feeder of DCDB for will be fed from existing New PCH DCDB.
 - c) The DCDB shall be flour mounted, modular, totally drawout, double front construction and shall have bottom cable entry. The other constructional details of each DC switchboard shall confirm to the requirement.
 - d) The DCDB shall be flour mounted, modular, totally drawout, double front construction and shall have bottom cable entry. The other constructional details of each DC switchboard shall confirm to the requirement.
 - e) DCDB at least 20% spare module of each type or minimum 2 no spare module of each type shall be provided.
 - f) The minimum sizing of battery shall be 200AH. However, exact size shall be finalized during detail engineering based on sizing calculations approved by Owner/Engineer.
 - g) 220V DC system shall be unearthed system.
 - h) All DC equipments like chargers, DCDB, JB etc shall be pre-treated with 7 tank and epoxy painted with power coating method of painting



and shall have shade as described in Electrical sections of the specification elsewhere.

- i) Separate Hydraulic trolleys of suitable capacity one no. each for handling battery of 220V DC system is to be supplied along with battery set.
- j) In battery room, suitable rating discharge resistor bank along with MCCB, Cable from battery terminals to MCCB and cable from MCCB to discharge resistor bank shall be provided. This is required during C10 capacity testing of battery set.
- k) Along with supply of complete battery set, total 05 battery cells in uncharged condition of each type, capacity shall also be provided.

1.4. SIZING

- a) The battery shall be sized for a discharge rate with end cell voltage per cell as 1.85V.
- b) The 220 DC battery shall be sized to cater the following loads with minimum duration as indicated.
 - (1) Momentary load (For a duration of upto 1 min.)
 - Tripping and closing load of breakers
 - (2) Continuous load (for 10 hours)
 - Indicating lamps on switchgear and control panels
 - Control room emergency lighting
 - Auxiliary relays
 - Numerical relays
 - (3) For arriving at the final battery capacity, the following shall be considered.
 - The temperature correction factor as given in IS. For this purpose, electrolyte temperature shall be considered as 10°C above the ambient temperature.
 - 25% margin for ageing as per IEEE guide lines.
 - A design margin of 10%.
- c) Battery shall be sized in accordance with the IEEE 485-1983 considering temperature correction factor, contingency and ageing factors. Minimum battery back up duration shall be 10 hour and shall be in line with battery duty cycles applicable for power plant emergency supplies. In addition 20% margin shall be provided.
- d) Float charger will be rated to cater the following:



- 1) Trickle charging current of the battery
- 2) Continuous load on the DC bus
- 3) 25% margin on (a)+(b)

- 1.5. The boost charger unit shall be rated such that the battery can be charged from fully discharged condition within 8 to 10 hours.
- 1.6. Under normal conditions, the float charger connected to the DC switchboard and battery shall cater to the continuous load of DC system plus trickle charging current of battery. In case of AC supply failure in the plant/to charger, battery shall meet the DC load. After restoration of AC supply, the fully / partly discharged battery shall be charged by boost charger and float charger continue to feed DC load. During this period, if AC fails, battery shall feed the load.
- 1.7. The sizing calculation for battery, battery charger shall be given by the Vendor for approval by Owner/Engineer
Current transducers shall be provided for DCS purpose in addition to local measurement meter.

Voltage / Current dual output transducer shall be provided for each 220V DC charger and 220V DC battery for DCS/ECP purpose.

Each 220V DC charger room shall be located in AC environment.

2. 220V BATTERIES

- 2.1. The batteries shall be lead acid HDP / plante types with transparent containers shall conform to IS:1652 for HDP / plante batteries.
- 2.2. The battery shall be closed top or sealed in type. Open type cells are not acceptable.
- 2.3. All the accessories required for testing and maintenance shall be supplied with the batteries along with electrolyte for first filling. Spare 10% electrolyte with shall be provided. These shall also include 3 volts DC voltmeter with suitable leads for measuring cell voltage and hydrometer for measuring specific gravity of electrolyte in steps of 0.005. The following tools and tackles shall be included:
 - Single / two cell discharge resistance with selector switch and tapping
 - Complete set discharge resistance with AH integrator for discharge measurement
 - Lifting device for removal and re-erection of battery cells
- 2.4. The batteries shall located on wooden stands.
- 2.5. All batteries 200 AH shall be of two tier design. The space between two rows shall be minimum 1.5 m.
- 2.6. Each battery room shall be having pressurised ventilation system.



- 2.7. Each cell shall be assembled in heat resistant, shock absorbing, robust transparent plastic boxes.
- 2.8. Electrolyte level shall be marked on the clear glass container or level indicators as applicable. The markings shall be for upper and lower limits.
- 2.9. Sufficient sediment space shall be provided so that the cells shall not have to be cleaned out during normal life.
- 2.10. Open type cells shall not be accepted. Anti splash type vent plug shall be provided for sealed-in type cell.
- 2.11. Separator between plates shall permit free flow of electrolyte. Separator shall be of acid resisting materials. Proper arrangement to keep end plates in position shall be furnished.
- 2.12. The cells shall be supported on porcelain insulator fixed on to the rack with adequate clearance between adjacent cells. The cell terminals posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion.
- 2.13. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set. Positive and negative terminal posts shall be clearly and indelibly marked for easy identification.
- 2.14. Lead coated bent copper plate, tubular copper lugs, teakwood clamp, bolts, nuts, washers, etc. shall be furnished for connection of outgoing copper conductor cables.
- 2.15. The battery shall be shipped uncharged with the electrolyte furnished in a separate non-returnable container. 10% extra electrolyte shall be furnished to cover spillage in transit or during erection.
- 2.16. The vent plugs provided shall be anti-splash type, having more than one exit hole shall allow the gases to escape freely but shall prevent acid from coming out. The design shall be such as to minimize water loss due to evaporation.
- 2.17. Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.
- 2.18. The racks for supporting battery cells shall be constructed of best quality seasoned teakwood, duly painted with at least three (3) coats of black anti sulphuric acid paint.
- 2.19. Racks shall be free standing type, mounted on porcelain insulators, suitable for double row single tier arrangement. The racks shall be constructed of best quality teakwood duly painted.
- 2.20. Numbering tags / plates for each cell shall be attached on to the racks.
- 2.21. Each battery shall be complete with accessories and devices, including but not limited to the following:
 - a) Acid resistant battery racks
 - b) Porcelain insulators, rubber pads, trays, etc.
 - c) Set of lead coated inter-cell, inter-tier and inter bank connectors as required for the complete installation
 - d) Electrolyte for first filling + 10% extra
 - e) Accessories for testing and maintenance
 - f) Acid resisting funnels



- g) Acid resisting jugs of adequate capacity
- h) Rubber aprons
- i) Rubber gloves
- j) Cell lifting straps
- k) PVC spill trays under the battery cells
- l) Bridging clamps
- m) Insulated Spanner for cells
- n) Float type level indicator
- o) First aid box
- p) +/-3 volts DC voltmeter with built-in discharging resistor and suitable leads for measuring cell voltage
- q) Hydrometer for measuring specific gravity of electrolyte in steps of 0.005
- r) Filler hole thermometer fitted with plug and cap and having specific gravity correction scale
- s) Pocket thermometers

3. 220V CHARGERS

- 3.1. The float cum boost charger offered shall be digital type, programmable with self diagnostic with silicon controlled rectifiers and diodes, complete with resistor/capacitor network for surge protection, connected in three phase full wave bridge circuit. All set points shall be programmable and the charger shall be provided with double redundant control channels.
- 3.2. Charger shall have provision for manual control if the auto mode fails. Load limiting features shall be provided. The charger shall be designed for adequate short time over load to take care of other DC loads connected to bus.
- 3.3. The chargers shall be provided with automatic voltage regulation in float mode and automatic constant current regulation in boost mode.
- 3.4. The charger shall comprise a continuous line up of free standing, floor mounted sheet steel panels, with all access from the front.
- 3.5. The panel shall conform to the degree of protection IP-42. Minimum thickness of sheet metal used shall be 2 mm.
- 3.6. Access doors shall be with concealed hinges and neoprene gaskets. Ventilating louvers shall be covered with fine wire mesh. Door over 600 mm width shall be double leaf design.
- 3.7. All equipment within the panels shall be arranged in modular units and laid out with sufficient space for easy maintenance. MCCB & switches, meters, relays, etc. shall be flush mounted on the front of the panels. Name plates of approved size and type shall be provided for all circuits and devices.



- 3.8. Electronic equipments shall be of modular design consisting of plug in modules in standard 19 inches metallic racks with metallic card guides. The cards should be provided with proper handles. Card to card wiring should be preferable through a mother board. Unplanned jumpering and track modifications are not permitted. Mechanical interlocks to prevent wrong insertion of cards should be provided. Each cards shall have its junction and test points identified.
- 3.9. The charger shall essentially comprise the following items:
- a) One (1)-moving coil DC voltmeter and ammeter of size 96x96 mm of suitable range for float and boost chargers. Necessary shunts for local and remote metering shall be provided.
 - b) One (1)-moving coil center zero ammeter, with shunt, size 96x96mm to read discharge / charge current of the battery
 - c) One (1) AC input volt meter with selector switch for AC supply monitoring
 - d) Two (2) 4-20mA outputs shall be provide for each DC voltage and DC Current for DCS.
 - e) Microcontroller shall have minimum last 10nos Fault records with current, voltage, date and time for all kinds of faults. It shall have history facility for all kinds of charger faults and the same shall be password protected for resetting purpose.
- 3.10. Fault indicating lamps shall be provided on the charger cubicle and a individual wired annunciation shall be provided on ECP and DCS/PLC for the following faults for each of the float and boost chargers.
- a) Main AC failure
 - b) AC input fuse blown
 - c) DC output fuse blown
 - d) U/V and current limit protection
 - e) Over voltage protection
 - f) Over current protection
 - g) Filter condenser fuse blown
 - h) Rectifier fuse blown
 - i) Tap Contactor off.
 - j) Earth fault
 - k) Control supply to charger fail
 - l) Microcontroller fault
 - m) The charger shall be fail-safe in operation.
 - n) Charger off loaded,

In addition to the above, any additional indication/alarms considered necessary during the detailed engineering shall also be provided.



- 3.11. The charger shall be natural air cooled and no external fans shall be provided to dissipate the heat developed within the panel. The main transformer of the charger can be mounted in a separate enclosure to reduce heating inside the charger.

For 220V Charger – Individual & Group alarm to DCS and ECP, charger voltage and current (DDU) signal to DCS and ECP.

The analog / digital signal shall be integrated hardwired to DCS and ECP. (Group alarm means signals for respective systems to be grouped in a common window for showing the alarm in DCS and ECP).

4. TESTS FOR BATTERIES

- 4.1. All routine and acceptance tests shall be conducted as per the relevant standards.
- 4.2. Capacity test and test for voltage during charging/discharging shall be carried out at site in presence of OEM on completion of installation and commissioning and immediately prior to putting the battery in service.

5. TESTS FOR BATTERY CHARGERS

- 5.1. The following routine tests shall be conducted at Vendor's works:
- (a) Visual checks for dimensions and general arrangement.
 - (b) Wiring checks
 - (c) Functional checks
 - (d) Voltage regulation for rated input supply for loads from 0 -100%.
 - (e) Load test to show the charger can deliver the rated duty without the current limiter device operating.
 - (f) Ripple measurement by oscilloscope at different loads.
 - (g) Demonstration of guaranteed efficiency and power factor
 - (h) Insulation test (with 500 V megger).
 - (i) Heat run test
 - (j) High voltage test, excluding electronic controller, at 2 kV AC for one min.
 - (k) Test to demonstrate Voltage stabilization for constant voltage regulator (With I/P voltage variation and starting) as specified in of datasheet.
- 5.2. All test certificates for type test and routine test shall be submitted for bought out items.



6. METERING

- a) All meters / shunts / transducers in DC system shall be class 0.5 or better.
- b) Ammeters shall be provided on all incomer to DCDB with remote indication at ECP and DCS/PLC
- c) Center Zero Voltmeters with Earth fault detection relay shall be provided in Bus PT of DCDB with remote indication at ECP and DCS/PLC.
- d) Center zero ammeters shall be provided on bus coupler and ties
- e) Charger DC output current and voltage shall be provided with remote indication at ECP and DCS/PLC.

7. 220 V DC battery charger shall comply with the particulars indicated in the following table.

Charger equipment

- a) All power diodes and control rectifiers shall be silicon type. Rectifier transformer shall be dry type, double wound, with copper conductor and class B insulation.
- b) Blocking diodes shall be fully rated and redundant so that failure of a single diode shall not incapacitate the system in any way. Necessary snubbers for hole storage effect shall be provided.
- c) MCCB shall be air break type, 3 pole / 4 poles as required by scheme, conforming to IS-13947. Performance category shall be P2.
- d) MCCB shall be equipped with three distinct positions for “ON”, “OFF” & “TRIP”. It shall be possible to lock the handle in “OFF” position.
- e) MCCB shall have built in short circuit and overload release.
- f) MCCB's shall be rated for continuous and short circuit current in conformity with the Battery and Charger equipment rating.
- g) Contactor shall be air break type with thermal overload relays having in-built single phase preventor.
- h) Fuse shall be HRC type and arranged for easy replacement. Semi-conducting device fuses shall be fast acting.
- i) Indicating lights shall be cluster type LED. Both lamp and lens shall be replaceable from front.



- j) Meters shall be 96 x 96 mm switchboard type, with 250 deg., antiglare glass, $\pm 2\%$ accuracy with zero adjuster on the front.

Wiring / Cabling

- a) The panels shall be completely wired up. All wiring shall be routed through wiring troughs. Wires shall be cross ferruled at both ends for identification.
- b) Panels shall have removable gland plates at the bottom for cable entry. All incoming / outgoing cables shall be terminated in suitable terminal blocks.
- c) Control terminal blocks shall be cage clamp type Wago make or approved equal . 20% spare terminals shall be furnished.

Grounding

- a) The charger panels shall have fully rated ground bus with two ground terminals, one at each end.
- b) Each terminal shall comprise two bolt drilling with M10 GI bolts and nuts to receive Owner's ground connection of 50 x 6 mm GI flat.

Painting

- a) The panels shall be chemically cleaned, phosphated and sprayed with two coats of high quality primer and stoved after each coat.
- b) The panels shall be finished in light gray shade no.631 as per IS-5 with two coats of synthetic enamel paint.

Controls

The following manual controls shall be provided on the front of the panel.

- a) Selection of float, equalising or boost charge for FCBC panel.
- b) Voltage setters for setting the output of float / equalising / boost charge. Setting shall be independent of each other so that setting of one voltage shall not require resetting the other.
- c) Current limit setter
- d) Alarm window reset button



Lamp / space heaters / receptacles

The charger panels shall be provided with

- a) Internal illumination lamp with door switch
- b) Space heater with thermostat control
- c) Pin 5A receptacle with plug
- d) Lamp, heater and receptacle circuits shall have individual switch fuse units.

8. 220V DC SWITCHBOARDS

- a) For feeding the 220V DC loads, 220V DC switchboard shall be provided.
- b) 220V DC switch board shall be separate and it shall be suitably tied up with the existing New PCH DC switch board.
- c) The switch boards shall be provided with suitable quantity and type of outgoing feeders for the auxiliaries, control supplies to various panels / systems. For each load and auxiliary, one separate feeder shall be provided. In addition, the following feeders shall be provided in switchboard.
 - 1) a) Feeders for Owner's use – 08 Nos. (16A) in DCDB
 - 2) b) Spare feeders – 20% of each type and rating with a minimum of two nos. feeders. This is the minimum quantity at the time of handing over the plant.
- d) The short circuit current rating of the switchboard shall be arrived considering the contribution from charger and battery with 5% margin, with a minimum of 20 kA.

Specific requirements

Positive and negative sleeved bus bars in the DC switchgear shall be completely segregated from each other by sheet steel partitions.

Module details

i) Incomer / Tie

The incomer / tie modules shall be suitable for DC application and shall be provided with

- Ammeter & Voltmeter



- Earth fault relay with potential free contact for remote annunciation
- Ammeter to read earth fault current
- Under voltage relay with timer
- Indicating lamps for ON, OFF, earth fault, under voltage conditions (22.5 mm size LED)
- Necessary hardware and circuitry for fault alarm and for lamp test and reset

ii) Outgoing feeders.

- These feeders shall have DC switch fuse units of draw out type, “ON” & “FAULT” indicating lamps.

TECHNICAL DATA SHEET – DC SYSTEM

Sr. No.	Description	Unit	Client specification	Bidders specification
1	STATIONARY LEAD ACID STORAGE BATTERY (HDP / PLANTE)			
1.1	Application		LHS	
1.2	No. of battery Bank required	Nos.	01	
1.3	Reference ambient temperature for design of electrical devices	deg. C	50	
1.4	DC system voltage	V	220V DC	
1.5	Ampere hour capacity of battery at 27 deg. C temperature for 10 hours rate to give final cell voltage of 1.85 volts/cell	AH	200 AH	
1.6	Discharge duty considered for battery sizing		*	
1.7	a) Required area of battery and charger room		* Two tier for batteries of 200AH capacity	



	b) Battery orientation/ mounting arrangement			
1.8	Charging method proposed		*	
1.9	Battery charger rating required to charge the battery in 8-10 hrs from fully discharged conditions (both Voltage and current range to be specified).		*	
1.10	No. of cells per set		110	
1.11	Open circuit voltage of each cell		As per IS 1651 & 1652	
1.12	Capacity factor considered for battery sizing		*	
1.13	The details of derating factor considered for temperature correction, ageing, future margin considered (min. 10 %) and any other required as per relevant standard		*	
1.14	Type of enclosure		Transparent	
1.15	Type of battery cell		Lead acid HDP / plante	
1.16	Life of the battery	hour	*	
1.17	No. of full charge – discharge cycles in a life	nos	*	
1.18	Recommended charging and discharging rate. a) Normal operation b) Quick charging c) First charging		*	
2	BATTERY CHARGER			
2.1	Number of charger required	Nos.	01	
2.2	Type		Float cum boost	
2.3	DC system voltage (nominal)	Volts	220 V DC	
2.4	DC system earthing		Isolated	
2.5	Ambient design temperature	deg. C	50	
2.6	DC bus load considered with break up a) Short time load	Amp for sec	*	



	b) Continuous load c) Starting current of largest connected DC motor			
2.7	Battery charger current and voltage rating a) Float b) Boost		*	
2.8	Float/Trickle charging current of battery		*	
2.9	Max. Boost charging current of battery Max. Boost charging voltage of battery	Amp Volt	*	
2.10	Max. time for Boost charging of battery	hours	10	
2.11	AC system data a) Supply b) Variation in supply c) Short circuit level d) Type of earthing	V, Hz % kA	415V, 3 ph, 50 Hz +/- 10 % in voltage +/- 5 % in Frequency 50 kA for 1 sec effectively earthed	
2.12	Performance a) DC voltage setting adjustment for float charger b) Maximum permissible variation in DC voltage (No load to full load) c) DC voltage setting adjustment for boost charging d) DC current adjustment for boost charging. e) Current stabilisation for constant current regulator for boost charger and time	% % sec % % % %	+/- 10 % of nominal voltage +/- 1 % 70 % to 100 % of max. boost charging voltage 30 % to 100 % of max boost charging current recommended by battery manufacturer.	



	f) Minimum permissible power factor at rated continuous load		+/- 2 % 0.8	
2.13	Voltage stabilization for constant voltage regulator	%	± 1 of D.C. voltage, with (a) AC input variation as specified. ± 5% during transient. (b) During switching ON.	
2.14	Cable entry		Bottom	
2.15	Permissible ripple content at rated continuous load Without battery With battery	%	 3 (maximum) 1 (maximum)	

4.7. TECHNICAL SPECIFICATIONS FOR EARTHING & LIGHTNING SYSTEM

Earthing and Lightning protection system shall be provided for the entire plant covering all buildings, structures, areas, including External Lignite Handling system if applicable at Plant end External Lignite Handling system at Mines end.

1. TECHNICAL SPECIFICATION FOR EARTHING SYSTEM

- a) The earthing system shall be designed for a life expectancy of at-least Forty (40) years and for maximum system fault current or 40kA for 1.0 Second whichever is higher. The minimum rate of corrosion of steel used for earthing conductor shall be considered as 0.12 mm per year while determining the conductor size. Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.
- b) For Transformer yard separate earth grid shall be suitably formed and treated earth pits including raisers shall be provided for transformer neutral. Earthing of Owner's equipment shall be carried out by the Bidder. Separate electronic earthing shall be provided each for DCS, PLCs, Variable Frequency Drives.
- c) Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.
- d) For transformers, neutral terminal shall be brought out through neutral bushing. Two separate neutral earthing conductors on separate pin insulators along the body of the transformer shall be brought down up to the base of the transformer from neutral bushing for earthing by suitable GI flats. These shall be connected to pipe electrode of chemical treated earth pits provided by the bidder.
- e) All kinds of treated earth pit shall have top cover painted pre-fabricated MS with proper identification with paint which includes details like earth pit identification no., earthing pit resistance value, date of testing and due date of testing. Such details can be pre-printed on specific identification boards and subsequently on every annual inspection, client has to only replace the PVC identification sticker with new details.
- f) The height of earthing pit shall be identical for entire plant areas.
- g) The earthing system shall conform to IS 3043.



2. DESIGN CRITERIA

- 2.1.** The earthing conductor shall be designed for carry highest fault level of the electrical switchgears except IPBD (minimum 40 kA) for duration of 1 second.
- 2.2.** The ambient temperature and allowable maximum temperature rise for steel welded joints shall be considered as 50 deg. cent and 50 deg. cent. respectively.

The earthing and Lightning protection shall be designed on the basis of following codes and standards:-

- (a) IS –3043-1987- Code of practice for safety earthing.
- (b) IS- 2309- 1989 – Code of practice for protection of building and allied structures against lightning.
- (c) IEE-80-1986 - Guide for safety in Alternating Current Sub Station grounding.
- (d) Indian Electricity rules.

The BIDDER shall undertake the soil resistivity measurements at site and select suitable type of conductors.

2.3. Conductor Material

The earthing system conductors and accessories shall be as follows:

- (a) Conductors above ground level and : Galvanised steel
in trenches
- (b) Conductors buried in ground or : Mild Steel
embedded in concrete
- (c) Electrodes : GS Pipe / Rod
- (d) Lightning protection air termination : GS Flat
and down conductors for buildings

2.4. Size of Conductors

(a) Main Earthing Conductors

The earthing conductor sizes shall be calculated as per the following formulae.

$$\frac{I_f}{A} = K \frac{1}{\sqrt{t}}$$

A = Cross-section area in sq. mm

I_f = Maximum a.c. rms ground fault current amperes.

t = Operating times of the protective device to disconnect the faulty circuit, in secs.

K = Factor depending on the earthing conductor, the insulation and other parts, and the initial and final temperature.

The factor “K” is determined by the formula

$$K = Q_c \frac{(B + 20)}{P_{20}} \text{Log}_e \frac{(B + \phi_t)}{(B + \phi_1)}$$

P₂₀ = Electrical resistivity of conductor material at 20 deg. C (ohm-m).

Q_c = Volumetric heat capacity of conductor material (J/deg.C/cu.m).

B = Reciprocal of temperature co-efficient of resistivity at 0 deg. C for the conductor.

φ₁ = Initial temperature of conductor, (deg.C).

φ_t = Final temperature of conductor, (deg. C)
depending on the type of joints.

The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.

Resistivity of soil Ohm-Meter		Reduction in thickness / diameter, mm
> 0	<10	8.0
>10	<25	7.0
>25	<50	5.5
>50	<75	4.5
>75	<100	3.0

>100	1.5
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2.5. Rod Electrodes

Galvanized steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits, electrodes shall be heavy-duty type (Class – C) GI pipes of suitable diameter with perforations. Electrodes installed in the test pits will have disconnecting facilities. The size of GI pipe shall be of minimum 3m length, 40-mm dia and of thickness 1.2 mm. All earthing electrodes (rods and pipes) shall be in RCC chamber with disconnecting links.

2.6. Earthing of Electrical equipment and travelling machines:

- a) Every electrical equipment shall have double earthing.
- b) A ring earthing system shall be provided within the machine to which electrical equipment shall be connected at least at two places.
- c) For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

2.7. Equipment Earthing Leads

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043 and also with a view to minimize the number of sizes and per clause no 6.0 to 9.0. Earthing connection to all equipment shall be through disconnecting type link.

2.8. Conductors for lightning protection system

The size of conductors for lightning protection system shall be decided based on mechanical strength.

3. General

- a) Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures in contact with switchyard earth, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used if rated voltage of equipment is above 250V. If the rated voltage is 250V or below, one earth lead shall be provided. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead. For HT/LT motors, earthing with GI flat shall be extended up to motor then from earthing flat to motor body shall be through sufficient / equivalent size aluminium power cable by bolting arrangement in order to have ease in motor maintenance.
- b) Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.



- c) All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.

3.1. Earthing Conductor Layout in Transformer yard

- a) Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.
- b) The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80. The aging effect of conductor shall also be taken into consideration while arriving at the maximum permissible step and touch potentials.
- c) Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 1000-mm. This shall be connected to the switchyard-earthing grid.
- d) Each earth leads of all transformer neutral shall be directly connected to separate treated pit pipe electrodes with disconnection link in RCC chamber which in turn will be connected to station grid. Earth leads of all Lightning arrestor shall be directly connected to two separate treated pit pipe electrodes with disconnection link in RCC chamber. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

3.2. Earthing Conductors Inside Building

- a) Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover.
- b) In case, the building has more than one floor, each floor shall be provided with earth grid as discussed earlier. Floor earthing grids shall be interconnected.
- c) Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.
- d) Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.
- e) Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment.
- f) Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.
- g) Earthing grid design shall be done in such a manner that the grid resistance is less than 1 ohm.



4. EARTHING SYSTEM INSTALLATION

- a) The spacing between two electrodes shall be atleast equivalent to twice the length of the electrode.
- b) Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.
- c) The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.
- d) When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall sealed after installation.
- e) The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.
- f) Metallic conduits and pipes shall not be used as earth continuity conductor. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead
- g) Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.
- h) Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc..
- i) Equipment bolted connection/All exposed parts after being checked and tested shall be painted with anti-corrosive paint / compound.
- j) Connection between the equipment earth lead and the grid conductor shall be necessarily welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
- k) The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.
- l) All bimetallic connections shall be treated with suitable compound to prevent moisture ingress. Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post.
- m) In areas where chemicals are used, the earthing strip shall be provided along the cable trays (above ground) to avoid damage.
- n) The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices



5. All utility and process pipe lines shall be earthed on entering or leaving the **hazardous** area. In addition steel pipes racks shall be earthed at every 25 meters. Earth continuity shall be ensured across all flanges.

After installation of entire earthing system for entire plant area, the following tests are to be conducted area-wise for ensuring healthy earthing system.

- Riser integrity test
- Touch and step potential test
- Grid integrity test
- Gravel resistance measurement
- Tag slope test
- Transient ground potential rise
- Vertical loop impedance testing

6. LIGHTNING PROTECTION SYSTEM

Lightning protection system shall consist of vertical air termination rods, horizontal roof conductors, downcomers, and pipe electrodes.

6.1. Need for Protection

The need for providing the lightning protection system shall be established by calculating risk index value for each building structure, etc., as per procedure given in IS-2309 AND IS/IEC 62305 and any building whose risk index is more than 40 shall be provided with lightning protection.

6.2. Lightning Protection System Layout

- a) The lightning systems design and installation shall generally comply with IS:2309 and IS/IEC 62305 code of practice for the protection of building and allied structure against lightning.
- b) Each down conductor shall be connected to a rod electrode which in turn shall be connected to the station earthing system through test links.

6.3. Lightning Protection System Installation

- a) Conductors of lightning protection system shall not be connected with conductors of safety earthing system above ground level.
- b) The down conductors shall be welded to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Wherever welded, the weld locations shall be treated to provide rust protection.
- c) Each down conductor shall be provided with a test link at a height of about 1000 mm above ground level. The lightning event counter shall be installed at less than 2.0 meters height from ground level. Down



conductor preferably installed at the corner of the building should be supplied with a 4 digit electro-mechanical lightning event counter housed in weather proof IP 65 enclosure. It shall be sensitive enabling the detection of minimum current of 250A (8/20 micro-second) and a max current of 100kA (10/350 micro second). It shall have a range of 0 to 9999, suitable for cable cross section up to 1000 Sq.mm and cable of withstanding a temperature range of minus 40 deg. Cent to plus 60 deg. Cent. Performances of the lightning event counter shall not be affected by extreme climatic conditions (operating temperature range minus 40 deg. Cent. To plus 70 deg. Cent)

- d) All the metallic structures within a vicinity of 2000 mm shall be connected to the lightning protection conductors.
- e) Lightning protection system shall comprise vertical air terminations, horizontal air terminations, down conductors, test links and earth electrodes. For tall buildings and structures, early streamer emission (ESE) type air terminal systems are preferred.
- f) Lightning protection conductors / air termination rods and circumferential bands provided at the top portion of chimney stack shall be lead coated.
- g) Horizontal air termination flats provided on top of boilers, main plant building , pump houses and other buildings shall be laid such that no part of the roof shall be more than 9 meters.
- h) Down conductors shall be cleated on outer side of building wall at 1000 mm interval or tack welded to outside of building columns at 1000 mm interval.
- i) Down conductors shall be connected to separate earth electrodes through test points located at height of above 1000 mm above ground level. These earth electrodes shall in turn be connected to earth mat at two points.
- j) Lightning protection conductors shall not pass through or run inside GI conduits.
- k) Lightning protection shall have as few joint as possible and avoid sharp bends.
- l) For off site buildings, which do not come under zone of protection, Lightning protection system, with horizontal/ vertical air termination and adequate nos. of down comers and earth electrodes shall be provided as per IS 2309- 1989 / IEC 62305.
- m) Lightning protection down conductor shall be directly connected to a separate earth electrode.

6.4. Minimum size and material of main earthing conductors:-

Systems	RECOMMENDED SIZE	
	Buried in earth	Above ground or Embedded in concrete
MAIN EARTHING CONDUCTOR		
a. 400KV system	40mm dia	75x10 mm flat
b. 6.6KV system	-Do-	-Do-
c. 415V system	-Do-	-Do-
EARTH ELECTRODES		
a.Rod Electrodes	3000mm long galvanised steel	
b.Pipe Electrode	40mm dia, 3000mm long galvanized steel class C pipe.	
MATERIAL		
a. Above ground	Galvanised Steel- Galvanizing as per IS 2629- 1985	
b. Below ground & Embedded in concrete.	Mild Steel.	

7. TESTING

7.1. Testing shall be conducted as per the relevant IS/IEC Standards.

Individual chemical treated earth pit resistance measurement shall be taken at site and for total earthing grid also.



4.8. TECHNICAL SPECIFICATIONS FOR LIGHTING

1. Lighting system shall be provided for the entire plant covering all the buildings, lighting as per aviation guidelines, structures, outdoor areas, roads for entire plant area, yards, perimeter (boundary wall inside / outside), conveyor galleries, junction towers, stacker reclaimer, security watch towers, security cabins, parking area, inside / outside shed area, conveyor area and corridors to these areas, external lignite handling system, LHS system Ramp area, highmast lighting tower (Min 4 no's), LHS system Feeder breaker area highmast lighting tower (Min 4 no's) etc.

In lighting system of any area, if LP is 3-phase then there shall be ELCB / RCCB in each phase at incoming side and MCB's for all outgoing circuits. If LP is of 1-phase then there shall be ELCB / RCCB at incoming side and MCB's shall be at each outgoing circuits.

Lighting for indoor shall be direct controlled and shall be through photocell timer for outdoor areas (photocell outdoor duty timer with photocell sensor, powder coated IP 65 protected box for outdoor applications. With time delay, Input - 230 VAC +/-15%, Potential free contact for switching ON & OFF light, along with 'NO' contact).

All types of outdoor panels shall be of double door type only with canopy.

2. CATEGORIES OF LIGHTING

- 2.1 The plant lighting system shall comprise the following four categories:
 - (a) Normal 240V AC Lighting System
 - (b) Emergency 220V DC Lighting System

2.1.1 Normal 240V AC Lighting System

In this system, the lighting circuits shall be fed by the 3 phase, 4 wire normal AC supply available from the normal lighting distribution boards. All the lighting fixtures connected to this system shall be available as long as supply is available from normal source viz., unit auxiliary transformer or station transformer.

2.1.3 Emergency DC Lighting System

During station emergency involving total AC failure, DC lighting fixtures shall be provided for movement of personnel in important areas/buildings at



strategic locations viz., near entrance, staircase, landings, all control rooms, emergency drives and switchgear area etc.

These fixtures shall be connected to lighting panels supplied from 220V DC battery. These lighting fixtures shall be normally 'OFF' and shall automatically get switched "ON", the moment AC power supply fails. When power supply is restored they shall be switched "OFF" automatically. As lignite-handling system is provided with dedicated battery and battery charger, DC lighting panel and the above scheme shall be provided.

3. The area wise distribution of lighting fixtures connected to the three systems covered: The Lighting towers shall be provided for unused open space.

Area wise Distribution of Lighting System in and out of the Plant

Area/building	Percentage Distribution of Lighting		
	Normal	Normal & Emergency	220V DC
Main Control room	70%	30%	15%
Transformer yard	90%	10%	-
All Switchgear rooms, cable spreader rooms, Battery Rooms etc	90 %	10%	10% (including strategic locations and exit doors)
Flood lights for area lighting	100 %	-	-
All aux buildings Control rooms	80 %	20%	10% (including strategic locations and exit doors)
Aux area bldgs - weigh bridges, Lignite Handling system, road lighting for the entire plant area plus from ELHS plant end to mines end roads, ventilation system, plant boundary wall, security cabins, weigh bridge area, main plant all entry gates plus respective security cabins etc.	100%	-	ELU



All roads including out of boundary roads leading to Plant area	100 %	-	-
Service and administration building if applicable	90%	10%	10% (including strategic locations and exit doors)

4. LIGHTING SUPPLY DISTRIBUTION SYSTEM

4.1 Normal AC System

Separate lighting transformer s/s shall be provided to the main lighting and sub-lighting distribution boards located at required location. Lighting distribution system shall be distinct and separate from the LT main distribution. Separate lighting transformers shall be used to supply lighting load.

- 4.1.1 For these systems, the distribution shall be by 415V, 3 phase 4 wire, 50 Hz supply with effectively earthed neutral. This supply shall be derived from 415V, 3 phase 3 wire, 50 Hz received from lighting supply changeover switch panel. Switchgear located lighting through delta/star lighting transformer. The secondary of lighting transformer will be connected to respective 415V, 3 phase 4 wire AC lighting distribution board (LDB). The LDBs will be provided with number of outgoing circuits controlled by RCCB, MCBs to feed the lighting panels distributed in and around the plant as well as to directly feed three phase street lighting and yard lighting supplies.

The lighting panels shall be individual phase wise and not complete three phase. Timers shall be provided in lighting panel for lighting of strategic locations.

The lighting transformer shall have ratio of 3 phase 3 wire 433 V / 433 V 3 phase 4 wire with tap of +/- 10% (in steps of 2.5%) on primary side. All the lighting transformers shall have at least 15% extra capacity after considering all connected lighting & receptacle loads. All the lighting transformers in non dusty area like main swgr rooms etc. shall be dry type and in dusty area like LHS conveyors etc. these shall be Resin cast transformers.

- 4.1.2 AC lighting panels shall have single phase 2 wire incomer controlled by earth leakage circuit breaker (ELCB) / RCCB and number of single phase outgoing circuits controlled by MCBs. Lighting fixtures in indoor areas shall be controlled from the respective lighting panels. Aviation warning lights also shall be contactor controlled for remote operation. The control of all such

lighting shall be done automatically through timer units. Manual switching 'ON and OFF' facility shall also be provided through auto/off/manual selector switch.

All lighting shall be segregated in three categories as follows.

Sr. No.	Description	Control	Remarks
1	Lighting required for 24 hours	Manual control from LP	All the lighting fixtures shall be segregated and grouped in three these categories in each area and feeding arrangement shall be done accordingly. Categories of lighting for this purpose shall be decided during detailed engineering in each area.
2	Lighting required during night hour only	Automatic control through timer and contactor. (with auto / off/manual selection facilities)	
3	Lighting required occasionally in unmanned area such as Battery rooms etc.	Manual control through switches mounted near entrance of the building.	

4.1.3 LPs to be used to supply 230V 1 phase 2 wire receptacles in an area. However 415V 3 phase 4 wire receptacles shall be fed from welding DBs/ACDBs. Further please note that supply for single phase receptacles shall not be fed from lighting LP. Lighting LP shall be separate and used only for lighting distribution. For single phase receptacles, separate LP is to be used for distribution across entire area.

Further, supply to that lighting distribution board shall be through cable from LP only, Lighting distribution shall be done through cables up to junction box instead of conduits/wires for the complete Area.

Power / welding receptacle (3 Phase 4 Wire) in switchgear room, transformer yard, conveying system, Material handling areas shall be provided.

Further, WDB (Welding Distribution Board) (3 phase 4 wire) shall be provided at switchgear room for feeding welding power supply requirement for entire area. One changeover switch shall be provided in each WDB with two



incoming power supply. The WDB incoming feeding capacity, number of outgoing circuits and number of WDB shall be decided during detail engineering. However, minimum no. of WDB's in area shall be 01 nos. with each having outgoing 16 nos. 63A output, minimum 12 nos. 16A 1-ph outputs.

All Three phase & Single phase receptacle shall be flame proof /weather proof for Lignite Handling system / Fire prone area of BALS make only.

4.1.4 Lighting system in LHS should be such that:

- (a) All lighting fixtures in above and under ground conveyor galleries are segregated and equally distributed on all three phases. This above ground lighting circuit should have auto switching through a lighting pre-set timer.
- (b) Periphery lighting of JNT, Transfer houses etc. shall be with timers for auto switching.
- (c) Lighting fixtures in houses and junction towers should be located at reasonable height to facilitate maintenance.
- (d) Illumination of access road to above ground hopper at lignite transfer point shall be provided.
- (e) Adequate size and type of lighting fixtures shall be provided at all locations.
- (f) For proper unloading of dumpers at unloading hoppers, suitable signal lighting of LED type with separate for ON / OFF with remote Push button and through remote (PLC) shall be provided.
- (g) For tunnel areas, 20% lighting shall be waterproof, fed from separate circuits.

4.2 220V DC Lighting System

Emergency DC lighting supply distribution shall be on 220V DC, 2 wire unearthed system. This power supply shall be obtained from the nearest 220V DC switchboard. DC lighting panel shall be provided for distribution of lighting supply. This panel shall have an incoming switch, under voltage relay and number of outgoing circuits controlled by switch fuses.

On failure of AC supply connected to the panel, under voltage relay shall drop out and shall switch 'ON' the incomer DC contactor and thus the DC supply to lighting circuits. An under voltage relay bypass switch shall be provided. Lighting fixtures in LLHS junction towers, screen houses shall be mounted at suitable height for maintenance.



5. The design, manufacture, testing, erection of equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. Nothing in this specification shall be construed to relieve the BIDDER of these responsibilities.

6. ILLUMINATION LEVELS AND CHOICE OF LIGHTING FIXTURES

All energy efficient LED fixtures shall be provided. In walkways, corridors lounge the energy efficient LED lamp fixtures shall be used. All lighting fixture shall degree of protection IP54 minimum. Flameproof lighting fixture shall be provided in hazardous area. The area-wise distribution of average illumination levels and type of luminaries shall be as indicated below:

Sl. No.	Area/ Structure	Avg. illum. Level in Lux.	Type of Fixture	Type of Luminaries (LED Fixtures)
1	TRANSFORMERYARD			
1.1	General	10-20	Flood light medium beam type	1 x 200 W mounted on building roof
1.2	Near equipment	50	Dust proof / dust tight well glass on fire partition walls	1 x 40W
2	VARIOUS OFF-SITE BUILDING			
2.1	Equipment room	150-200	Industrial medium bay for mounting heights above 6 M	80 W
2.2	Switchgear room	200-250	Industrial type with vitreous enamel reflector up to mounting height of 6 M	2 x 20W
2.3	Outside working areas	70	Flood light medium beam	100W
3	LIGNITE HANDLING PLANT			
3.1	Conveyors enclosed	- 100	Dust proof well glass with reflector wire guard.	1 x 40 W



3.2	Underground conveyor tunnel	40	Flame proof industrial bulk head well glass type	70W
3.3	Crusher house & Junction towers	100	Dust proof / dust tight well glass with reflector wire guard	1 x 40W
3.4	Open lignite stock pile and lignite runoff pond	15 – 25	Flood light (tower mounted)	1 x 250W
3.5	Coal unloading, track hopper stacker reclaimer	50-80	Flood light (Tower mounted flood light shall be provided for illumination for Ramp with suitable lux level)	1 x 250W
3.7	Lignite stock pile Shed area	50 - 20	Industrial high bay with anodised aluminium reflector	1 x 200 W
This is only indicative. Details will be decided/worked out during detailed engineering and subject to Owner's approval.				
4	ROAD & YARD LIGHTING			
4.1	Roads	20	Street light	1 x 90W
4.2	Perimeter (compound) lighting	10 – 20	- do -	1X150W Boundary
4.3	Yard lighting	15 – 20	General purpose Flood light	200W
4.4	Parking area	50	Industrial type with vitreous enamel reflectors channel mounted type	1 x 40W Light fixture
5	GENERAL			
5.1	Corridors, walk-ways, staircase, etc.	100	Industrial type with vitreous enamel reflectors channel mounted box type	1X20
5.2	Lockers, toilets, wash rooms, etc.	80	Channel mounted box type The details are indicative only. Details will be decided/worked out during	1 x 20 W



			detailed engineering and subject to Owner's approval	
5.3	Building periphery lighting	-	Industrial well glass with	1 x 40 W
5.4	Watch towers		-do-	200W LED fitting
5.5	Boundary wall		-do-	200W LED fitting
5.6	Various lighting high mast for the areas like lignite stock yard area, outplant lignite stock-yard area etc. to be provided			
6	DC LIGHT FITTINGS			
6.1	All areas	-	Industrial bulk head or industrial well glass with reflector	1 x 22 W LED fitting

In entire Lignite handling system, single phase and 3-phase receptacles shall be flameproof, weatherproof type only. One acid proof receptacle in each battery rooms for cell charging shall be provided.

One receptacle in transformer yard for oil filtration machine connection shall be provided.

At every watch tower installed along periphery of plant, should have minimum 02 nos. single phase power socket, lighting inside cabin and outside cabin etc.

security system related power supply points, computer points etc. shall be provided and requirement shall be furnished by Owner/Owner's Engineer / Consultant during detail engineering.

In every weigh bridge, power supply for computers, power supply for weigh bridge electronic system, air conditioning power supply, sufficient number of single phase sockets etc. shall be provided as per Owner requirement.



In all plant area lighting fixtures shall be provided near to all major equipments for proper illumination for monitoring and maintenance of equipments.

BIDDER may change the type of fixture to be used in different area against indicated above with approval from Owner/Engineer, provided minimum illumination level as indicated above is maintained. Lighting shall appear aesthetically good. Lighting shall be provided for all areas in the plant and not limited only to the areas indicated above.

BIDDER shall measure the lux levels in the above areas (measured at the working plane) using suitable devices/meters as per relevant standards to prove the specified values.

Electrification of entire plant buildings as well as non-plant area buildings including below mentioned areas shall be in the scope of Bidder. Electrification includes providing LED lighting for indoor and outdoor area both, ceiling fans, wall mounted fans, pedestal fans, split air conditioner (quantity during DDE), sufficient capacity water cooler (quantity during DDE) etc. Entire electrification shall be carried out through concealed wiring for building / office areas.

- Entire main plant area buildings including boiler and TG complex

Entire balance of plant area buildings (as per Civil layout) lignite handling system, entire plant area weigh bridges, entire conveyor Gallery including junction towers, entire plant road lighting, entire plant boundary area inside and outside lighting, entire plant area high mast area lighting at strategic locations decided during DDE, sanitation facility area, security gates, watch towers, etc.

- Entire Service building including all floor office area (as per Civil layout)
- Security barrack area establishment (as per Civil layout)
- Security gate complex including office area
- Various parking area across entire plant area
- Any building which is not mentioned in above list but becomes part of plant area

7. LIGHTING SYSTEM DESIGN

- 7.1 The lighting system design shall comply with the acceptable norms and the best engineering practices. The system design shall consider principles of lighting specified in following paragraph. The lighting layout shall be designed to provide uniform illumination with minimum glare. The layout design shall meet all the statutory requirement, local rules etc.



7.2 INDOOR LIGHTING

The recommended values of illumination level for various areas in the plant are indicated in the Table above. Following factors shall be considered while arriving at the utilisation factor to determine the number of fixtures for each area/buildings in the plant.

7.2.1 Maintenance Factor:

- | | | |
|--|---|------|
| (a) Air-conditioned clean interiors like office rooms | : | 0.8 |
| (b) Clean interiors such as Office rooms | : | 0.75 |
| (c) Industrial areas with normal interiors such as workshops, stores. | : | 0.7 |
| (d) Industrial areas with dusty interiors. | : | 0.6 |
| (e) Industrial areas with very dusty interiors such as coal handling area, crusher house and junction towers | : | 0.5 |

7.2.2 Reflection factor for wall/ceiling

- | | | |
|----------------------------------|---|-----|
| (a) White and Very light colours | : | 0.7 |
| (b) Light colours | : | 0.5 |
| (c) Middle tints | : | 0.3 |
| (d) Dark colours | : | 0.1 |

7.2.3 Utilisation factor considering the room index at applicable surface Reflection factors. The working plane shall be considered at 0.85 m from the Floor level.

7.2.4 Value of the ratio of spacing (S) to mounting height (H) shall be commensurate with the type of fittings selected, uniformity of illumination. The suspension height for suspended fixtures shall not exceed 1 meter.

7.3 OUTDOORS LIGHTING

7.3.1 The recommended illumination levels for outdoor areas are indicated in the above table.

7.3.2 Mounting height, spacing of Floodlights shall be based on lamp wattage, uniformity of illumination and vertical angles. Ratio of minimum to average illumination shall not be less than 0.3 and for minimum to maximum shall not be less than 0.5.

7.3.3 Maintenance factor shall be generally 0.6 under average conditions.

Lighting for lignite stockpile - tower lighting shall be provided and minimum 04 nos. of towers are to be provided for lignite stock pile, ramp and weigh bridge area. Its total electrical load shall also be provided in ELHS mines



end LT MCC with isolation transformer. Further, light fittings can be taken at ground level from top through motorised arrangement for maintenance purpose.

Lighting fitting in shed shall be of telescopic type for carrying out easy maintenance.

7.4 ROAD LIGHTING

- a) Road lighting provided shall consider the general visibility on the roads and reasonable uniformity in illumination levels.
- b) Lighting design for roads shall consider a maintenance factor of 0.6 for average conditions.
- c) Ratio of minimum to average illumination shall not be less than 0.3. The road lighting layout shall consider the width of the road to decide whether the lighting poles shall be located on one side, on either side.
- d) Mounting height of the luminaries shall be generally 9 m.
- e) For the yard lighting, suitable poles, towers distributed suitably shall be provided. The Flood light towers shall be made of standard galvanised structural steel members, suitable ladder for accessing and platform at the lighting fitting levels shall be provided for maintenance.
- f) Streetlights shall be provided with MCBs in the junction boxes.
- g) Streetlight JB's shall be IP55 and installed at 1.5 ft above pedestal top. Minimum size for 2 way street light JB's shall be 275 x 250 mm JB's shall be provided 1.5 m above grade level.

8. SWITCHES, RECEPTACLES & CEILING FANS

- 8.1.** In the plant areas, the lighting circuits shall be controlled directly from the MCBs in the lighting panels. Wherever the lighting panel is not in the same area, separate switches shall be provided. For cabins, rooms etc., separate switches shall be provided for each point. Similarly, for entrances, building periphery lighting separate switches shall be provided. Industrial toggle / decorative switches shall be provided as per the requirement of area of utilisation.
- 8.2.** 240V, 50 Hz, 3/5 pin Power Receptacles (5A & 15A) shall be provided in all building/areas of the plant. Inside a building, receptacles shall be provided at regular intervals so that any point of the building is not more than 10 m from the switch. Inside each of the operator cabins/ office areas at least 5 (five) receptacles shall be provided and the same shall be indoor/outdoor/Flameproof as per the location. Single phase receptacle shall be flame proof, weather proof for Lignite Handling system, Oil/Fire prone area, transformer yard area.



- 8.3.** In all office areas/ operator cabins, sufficient numbers (based on the room size) of double ball bearing 1200 mm sweep bottom make-up ceiling fans shall be provided.

9. LIGHTING DISTRIBUTION BOARDS (LDB) & LIGHTING PANELS (LP)

- 9.1.** Each of the LDBs shall be provided with output voltmeter and ammeter along with selector switches, 'Supply ON' indicating lamps, etc. The LDBs and LPs shall be sheet steel enclosed and shall be fully dust and vermin proof, with a degree of protection of IP 52. Outdoor panels shall be weatherproof types with IP-55 degree of protection. The switch boxes receptacle boxes etc. shall be made up of 18 SWG sheet steel.
- 9.2.** The distribution of lighting fixtures shall be such that the loading on each phases of the LDB is approximately equal.
- 9.3.** Bottom cable entry shall be provided in all LDB, LPs, JBs, Switches, and Fixtures.

10. WIRING

- 10.1.** 1100/650V grade stranded copper conductor, PVC insulated, colour coded, wires laid in GI conduits of size 25 mm and 20 mm shall be used for lighting in non hazardous area. In the hazardous area viz., hydrogen generation plant and outdoor areas like transformer yard, switchyard, boiler and road lighting, cable wiring shall be adopted. The specification of cable shall conform to the details indicated in Section 15.14. Wiring shall be through lighting cables instead of GI conduits for entire plant area.
- 10.2.** Minimum size of wires in case of conduit wiring shall be 2.5 sq. mm in case of lighting and 4 sq. mm in case of receptacle wiring. Minimum cable size in case of cable wiring shall be 4-sq. mm Copper. In case of outdoor receptacle wiring, the minimum cable size shall be 6 sq., mm Copper.
- 10.3.** Wires of lighting and power receptacles will be carried out in separate circuits. Wires of AC and DC lighting systems shall be carried out in separate circuit.
- 10.4.** For outdoor lighting, the cable shall be buried at a minimum depth of 750 mm from ground level or run in cable trays. The buried cables shall have suitable bedding, protective covers & markers.
- 10.5.** Material used for saddles, clamps, JBs, etc., shall be galvanised.
- 10.6.** Loop in / Loop out from fixture is not acceptable.
- 10.7.** Buildings shall have concealed wiring with minimum 2.5 sqmm cable using PVC conduits.

11. LIGHTING CIRCUIT DESIGN

- 11.1.** In an area, the lighting fixtures shall be arranged in different phase / LPs such that even in case one lighting panel is faulty complete lighting is not affected. In case of any location the lighting shall be arranged from all



three phases. The lighting panel shall be provided at every alternate Floor of the building / structures and shall be easily accessible from the stairs.

- 11.2.** The circuit loading on each circuit shall be restricted to 70% of the MCB rating. Additional 2 MCB s / circuits shall be provided in each LP s as spare.
- 11.3.** The voltage drop from LDB and any fixture shall not exceed 3%.

12. TESTS

Acceptance tests & routine tests for the lighting fixtures and accessories covered in this specification shall be carried out as per the relevant standards.

13. LIGHTING FOR AVIATION LIGHTING

- 13.1.** Each landing of staircase shall be provided with one dust-proof, dusts light 40W LED type fixture. Necessary operating switches for all fixtures shall be provided at zero meters.
- 13.2.** Aviation lighting shall be as per ICAO Guidelines.
- 13.3.** The location of the fixtures, receptacles and pull boxes shall be finalised such that the same is easily maintained.
- 13.4.** The location of lighting JB's shall be closer to the platform/walkways to facilitate maintenance.
- 13.5.** Sufficient temporary lighting shall be arranged by bidder at the time of construction and commissioning phase till commissioning of permanent lighting for all the areas of power plant.

4.9. TECHNICAL SPECIFICATIONS FOR CABLES

1. CABLES

1.1. HT CABLES

For Material Handling plant/fire prone area following cable shall be provided.

"System cables shall be 6.6kV (UE) /11 KV (E) grade suitable for use in medium resistance earthed system, with stranded & compacted aluminium conductor, extruded semi conducting screen over conductor, extruded XLPE insulated, extruded semi-conducting followed by copper tape screened, extruded PVC Type ST – 2 inner sheathed, Single round galvanised steel wire armoured ,overall extruded PVC Type ST – 2 FRLS outer sheathed, single/multi core , conforming to IS 7098 (Part II), IEC-502 for constructional details and tests."



1.2. LT POWER CABLES

For Material Handling plant/fire prone area following cable shall be provided.

"LV Power Cable shall be 1100 V grade, single / multi core, armoured, stranded aluminium conductor, XLPE insulated, with extruded inner sheath FRLS PVC type ST-2, galvanised single round steel wire/strip armoured and extruded outer sheath made of FRLS PVC compound, overall PVC ST-2 FRLS, generally conforming to IS 7098 Part-I. The cables used for DC system shall be of single core type. All other details shall be same as that of HT XLPE cables. Minimum conductor cross section of power cables shall be 4/6-sq. mm."

1.3. CONTROL CABLES

For Material Handling plant/fire prone area following cable shall be provided.

"Control cables shall be 1100V grade, multi core, minimum 2.5 sq. mm cross section, stranded copper conductor having minimum 7 strands, PVC type-C insulated, extruded FRLS PVC type ST-2 inner sheathed / galvanised steel wire armoured, overall extruded PVC type ST-2 FRLS outer sheathed generally conforming to IS 1554 Part-I. In situations where accuracy of measurement or voltage drop in control circuit warrants, higher cross sections as required shall be used."

1.4. LIGHTING WIRES

For entire lighting system, 1100V grade, 2-core armoured cables shall be used instead of conduit and lighting wires. Minimum cross section of copper wires shall be 2.5 sq. mm for lighting circuits and 4-6 sq. mm for receptacle circuits.

Signal / communication cables are to be laid in separate conduits in order to avoid any interference and damage to cable in entire plant area.

1.5. TRAILING POWER AND CONTROL CABLES FOR MOBILE EQUIPMENT.

Flexible cable shall be used for equipment with vibration, movement or portability.

Conductor material / Armouring / Insulation / Inner-Outer sheath for HT/LT Power, Control cables used in Mining area if applicable shall be as per DGMS guidelines and specifications.

2. CABLE PROPERTIES

- 2.1.** All single core power cables will have wire / strip armouring of aluminium, whereas multi core power cable will have galvanised steel wire / strip armouring.



- 2.2.** The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.
- 2.3.** The outer sheath of FRLS PVC compound shall meet the following performance requirements:
- (a) The critical oxygen index value shall be minimum 29 when tested at $27 \pm 2^{\circ}\text{C}$ as per ASTM-D-2763-77 and the temperature index shall be minimum 250°C at oxygen index value of 21 when tested as per NES-715.
 - (b) The maximum acid gas generation as determined by titration method shall be less than 20% by weight when tested as per IEC-754-1 (1994).
 - (c) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2743-7 (1977).
 - (d) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53377.
- 2.4.** The finished cable shall pass the flammability test as per IEC-322-1 (1993) and IEEE-3733. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475 (1977).
- 2.5.** Cables for devices mounted on or near hot surfaces of Steam Generators, Turbine Generators, Main steam etc will have heat resistance type outer sheath.

For lignite air lock feeder motor, insulation class shall be H, motor cooling fan shall be AL and motor incoming cable shall be through local JB and cable shall be suitable for its use in high temperature application like PTFE cable or heat resistance type Copper power cable. Likewise for all hot zone area drives, this is applicable.

All the HT, LT power cable, Control cable, DC supply cable, instrumentation cable, etc. shall be having different colors of outer insulation so that can easily be identified. The color of the outer insulation to be decided during the detailed engineering.

3. DESIGN CRITERIA FOR CABLE SIZING

3.1 POWER CABLES

Power cable sizes shall be selected on the following basis & shall be as per final sizing calculations.

- 3.1.1** Power cables shall carry the full load current of the circuit continuously under site conditions considering the condition listed below: :-

- Ambient design temperature 50°C .



- Maximum allowable temperature under normal full load condition and under short circuit condition based on material selected (XLPE).
- Maximum short circuit fault current as specified in relevant section.
- Ambient temperature for underground cables, 40 deg. C.
- De-rating factors:(a). Cable laid in air - 0.7 (b) Cable laid in ground touching each other – 0.6.

3.1.2 Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Fault clearing times for 6600V motor feeders and transformer feeders having high-set instantaneous protection shall be 0.16 sec., whereas tie between two 415V switchgear and any two 6600V switchgear shall be 0.5 sec, and for incomers and tie feeders 1.0 sec.

3.1.3 NIL

3.1.4 For the cables to 415V motors and feeders protected by fuses, the cross section shall be chosen according to the cut-off current of the fuse and its fusing time.

For all the cable for lignite gate valve drives, there shall be additional protection provided against high temperatures in that area like high temperature resistant tapes may be provided over the finished cables.

3.1.5 Voltage drop from transformer secondary to motor terminals during starting of motors will be limited to the following values:

(i) For LV motors – 15% of the rated voltage.

3.1.6 Voltage drop in feeder cables shall be limited to 3% during full load running condition. Voltage drop from transformer secondary to motor terminals during full load running of motors will be limited to 5 % of rated voltage.

3.1.6 For power supply to valve actuator motors, actuators of various isolating and regulating dampers and exhaust fans, 3 core 2.5 sq. mm stranded copper conductor cable may be used in view of ease of termination. These cables shall be in other respects similar to cables described in Clause 1.2 above.

3.1.7 DC System Cables:-

1100 V grade, single or two cores cables as specified in LT power cables will be used. Only Single core cables will be used from batteries/ battery chargers to main DCDB, between main Distribution Board, from



main Distribution Board to sub distribution board, main DC supply to various system cabinets/panels, Switchgears etc.

- 3.1.8 Design Calculation for arriving at cable size shall be submitted for Owners approval.

3.2 CONTROL CABLES

- 3.2.1 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity. Minimum 2.5sqmm cables for within panels, while 4.0sqmm between independent panels/equipment shall be used for connection of CTs and PTs to the load. In case 2.5/4.0 sq. mm conductor impose unacceptably high burden on CTs/PTs higher conductor shall be used. The conductor material shall be copper.
- 3.2.2 Voltage transformer leads shall be checked for voltage drop which shall be limited to within 0.2/0.5/1% as specified elsewhere. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 2.5/4.0 sq. mm conductors exceed this value, higher conductor sizes shall be used.
- 3.2.3 The multi-core cables shall have 2 to 4 nos. cores on spare. The grouping of cables for critical application shall be avoided.

For the control cables suitable size printed cross ferruling to be provided. No cable shall be laid without cable tags at specified distance and cable dressing.

4. CABLE TERMINATIONS

- 4.1. All 6.6kV termination kits shall be of heat shrinkable type and suitable for XLPE insulation and the same shall have been tested for a short circuit value as specified in clause 3.1.2 above. Weather proof Double compression type cable glands and heavy duty , tinned , long barrel copper lugs shall be used for termination.
- 4.2. All 1100V termination for XLPE/PVC power cables and control cables shall be by Double compression weather proof type cable glands and heavy duty, tinned, long barrel copper lugs shall be used for termination.
- 4.3. Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and be of robust construction capable of clamping cable and cable armour firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating.
- 4.4. Cable lugs for power cables shall be aluminium solderless crimping type conforming to IS:8309 suitable for aluminium conductor cables and for control cables shall be tinned copper type.



- 4.5.** Cables shall be laid in trays /trenches/ conduits by the bidder. Also joint markers shall be provided at each joint.

5. CABLE JOINTS

Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length, they shall be heat shrinkable types having a short circuit with stand capacity value as specified in clause 3.1.2 above. Lugs shall be heavy duty, tinned copper, long barrel. All cable glands shall be double compression, weather proof. For fire prone areas, flame proof cable gland shall be used.

6. CABLE CARRIER SYSTEM

- 6.1.** The cable carrier system shall be designed considering the following :
- (a) Facility for easy laying of cables.
 - (b) Access to maintenance.
 - (c) Neat and aesthetic appearance.
 - (d) Safety of equipment & personnel.
 - (e) Ground water seepage.
 - (f) Drainage system for oil and water.
- 6.2.** Cables shall be laid in prefabricated ladder / perforated type trays and in conduits. Also joint markers shall be provided at each joint. The cable trays shall be laid vertical only Lignite area.
- 6.3.** Cable trays and supporting structures in chemically corrosive area like battery room shall be mild steel painted trays finished with chlorinated rubber based paint/epoxy paint.
- 6.4.** Cable trenches will be avoided.
- 6.5.** No direct underground burial cables shall be laid except lighting tower, street lighting. For some exceptional case like isolated individual equipments it shall be allowed after Owner's approval.

7. CABLE INSTALLATION AND ACCESSORIES

- 7.1.** All material and accessories required for cable installation like cable trays, tray covers, support steel, etc., shall be hot dip galvanized and conduits/pipes shall also be hot dip galvanized. The racks/trays, conduits/pipes, trenches required to route the cables to individual equipment shall be supplied and installed by the BIDDER.
- a) Separate trays shall be provided for HV Power/LV Power (AC&DC)/Control & Instrumentation cables.



- b) After laying all the cables, BIDDER shall dress all cables by clamping at every metre, so that the cables are securely held and aesthetically good.
- c) Cable trays shall be avoided very close to the pipes carrying high temperature steam. When they are inevitable, it shall be laid after OWNERS approval and suitable insulation material shall be provided between the cable trays and pipes.
- d) Wherever cables have to be laid to top of cooling tower and different elevations of chimney, the cables shall be laid in conduits embedded in concrete. The number of conduits shall be subject to Owner's approval considering different conduits for different phases / application.
- e) kV cables shall be laid only in one layer. 1100 V cables up to 120-sq. mm. can be laid in two layers. Control and Instrumentation cables can be laid in three layers.
- f) No cable trenches shall be lignite handling system.
- g) Cable shall not be laid inside lignite conveyor gallery, shall be outside conveyor gallery with suitable maintenance and approach platforms.
- h) Wherever any cable has to cross conveyor, the crossing should take place above the conveyor either above the cross over ladder or by providing separate platform.
- i) For LT power cables having termination size more than 120 sq.mm, termination to motor shall be through JB. Higher size cable shall be terminated between MCC feeder and local JB. Suitable size copper cable to be used between local JB and respective LT motor.
- j) All the cable trays shall have painted identification tag at an interval of 5 meter. Separate perforated cable trays of suitable size along with supports to be provided for lighting cables, only one layer of cables per tray shall be allowable. Cable rack shall be prefabricated and of Galvanised steel.

7.2. Cable Carrier Installation practice

- a) Minimum level difference between two tiers of horizontal cable trays in building, shall be 275 mm. In vertical raceways with multi tiers the tiers shall be located atleast with 400 mm intervals.
- b) The width of the cable tray shall be minimum 150mm and limited to 600 mm.
- c) Separate cable trays/tiers shall be provided for different voltage grade cable viz., 6.6 kV power, 415V/240V power, control cables and instrumentation cables. Cable laying in tray shall be in double layer only.
- d) Cable trays shall be supported at every 1000 mm interval.
- e) Cable trays shall be welded to the mounting/carrier structures.
- f) All outdoor cable trays shall be erected in vertical plane. Vertical trays (raceways) and all outdoor cable trays shall be provided with removable 16 gauge galvanised MS sheet covers.
- g) Each continuous laid out length of cable tray shall be earthed at minimum two places by MS flats of minimum size 25mm x 3mm, the distance between earthing points shall not exceed 10 metres.
- h) When cables are taken in vertical raceways /trays and they pass from one floor & other floor pipe sleeves in concrete shall be provided.



- i) In heat zone areas as far as possible the cables shall be taken away from that area to avoid heat. If Cabling in heat zones cannot be avoided, the cables shall be terminated in a junction box of IP 67 protection class away from the heat zones and small length of cables may be laid from junction box to the respective equipment to facilitate easier replacement in case of fire. Bunching of cables in the heat zones shall be avoided and laid in separate groups.

7.3. UNDERGROUND CABLE TRENCH

An underground cable trench is an excavated channel used to safely route, protect, and manage power and telecommunication cables. These systems protect cables from mechanical damage, chemical exposure, and environmental factors. Redundancy in cable layouts is also common to ensure continuous power supply in case of system failures.

Standard Installation Process

The process of laying cables within an underground trench involves several precise steps to guarantee long-term system integrity:

Excavation: Digging a trench to a specific depth (typically 950 mm to 1.5 m) based on cable voltage and local regulations.

Sand Bedding: Placing a 100–150 mm thick layer of fine, soft sand (or dune sand) at the bottom. This prevents sharp rocks or soil movement from damaging the cable insulation.

Cable Laying: Positioning the cables atop the sand. If multiple cables are installed, they are placed with deliberate horizontal and vertical spacing to prevent mutual heating.

Protection & Warning: The cables are covered with another layer of soft sand. For cables, protective bricks, warning tiles, or concrete covers are used to alert future excavators.

Backfilling: The trench is filled with the original soil and compacted using a roller.

Thermal Considerations

Underground cables generate heat during operation, and if this heat is not properly dissipated, it can lead to cable degradation and potential system failures. The thermal properties of the surrounding soil play a significant role in determining how much heat the cables can safely carry.



Bidder must calculate the soil's thermal resistivity and select the appropriate cable type and installation method to ensure that the system operates within safe temperature limits. In some cases, additional cooling measures, such as heat sinks or specialized backfill materials, may be required.

In areas with unstable soil or high groundwater levels, additional protective measures may be necessary to prevent moisture ingress, which can cause corrosion or electrical faults.

Safety Standards and Compliance

Compliance with local and international safety standards is essential to ensure that underground cable installations are safe and reliable. Regulations typically cover a range of topics, from trenching and excavation practices to electrical safety protocols and environmental protection measures.

Standards organizations, such as the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE), and local regulatory bodies, provide detailed guidelines on how underground cables should be installed and maintained. Following these guidelines not only ensures safety but also helps extend the lifespan of the cables and prevent costly repairs.

7.4. Cable Installation

Cables to each circuit shall be laid in one continuous length. Cable jointing and splicing shall be avoided. Jointing shall be allowed only for the cases where the route length is more than the maximum possible drum length. Drum length of the cables shall be so chosen that straight through joints are eliminated. However, the drum length shall not be less than the following lengths:

1100V grade power cables – 500 meter

1100V grade control & instrumentation cables – 1000 meters

Outdoor cable installation

- (a) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in hume or steel pipes. For road crossings, the pipe for the cable shall be buried at not less than 600 mm. Hume pipes shall be preferred to steel pipes from the point of view of corrosion. Minimum 20% of total laid hume or steel pipes to be kept empty (if possible in top two layer) for future requirement.



- (b) The cables shall be tied to tray rungs by means of 3mm dia. nylon cord at an interval of 5000 mm and also at bends.
- (c) For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls/slabs for passage of cables into a building from cable trays/racks/cable trenches located outside the building.

8. CABLE TRAYS AND COVERS

- 8.1.** Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 12 gauge (2.5 mm thick) mild steel sheets. Cable tray covers shall be provided for all cable trays and raceways. The cable tray accessories like trays, elbows, bends, etc., shall be fabricated and galvanized before bringing to site. Cable tray covers shall be fabricated from 16 gauge (1.7 mm thick) MS sheets. All the sheet steel shall be hot dip galvanized.
- 8.2.** 1100 V rated cables of sizes 120-sq. mm and above shall be laid in single layer. Single core cables used for 3-phase AC power circuits shall be laid in Trefoil form with suitable PVC aluminum clamps to hold the cables.
- 8.3.** The sizing of cable trays to avoid crowding and crises crossing of cables.
- 8.4.** Separate cable trays shall be provided for fire alarm/fighting, DC system cables communication system cables to avoid damage to these cables during a fire in other cables. Communication cable to be laid inside conduit only to negate interference from HV power & control cables.
- 8.5.** Slotted angles shall not be used for cabling. In all locations smaller size cable trays of 50 mm / 100 mm wide shall be used for one or two cables.
- 8.6.** 8.6 Cable trays shall have standard width of 150 mm / 300 mm / 600 mm and in standard length of 2.5 meters.

Cover shall be provided on cable rack / cable tray wherever possibility of Lignite / Dust accumulation just like sheds

8.7. Bending radii for cables

The bending radii for various types of cables shall not be less than those values specified by the cable manufacturer.

8.8. Terminations, clamping and miscellaneous details

- (a) Cable entry to motors, push button stations and other electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.
- (b) Identification tags made from aluminium sheet shall be attached to each end of each cable by means of GI binding wire. Tags shall be additionally



put at an interval of 20 metres runs of cables in trench/trays and in pull boxes.

- (c) All cable terminations shall be done with solderless tinned copper crimping type lug. Cable terminations shall be done with double compression type brass cable glands. For transformer feeders, HT motors, LT motors of 110kW and above only 'Amp' make lugs shall be used at both motor and switchgear ends. Wherever required, necessary bi-metallic strips / round ferrule are to be used for cable termination.
- (d) Control cable termination: 'Wago' type or equivalent type cage connectors shall be used.
- (e) Saddle type clamps to suit number of cables to be clamped at a particular location shall be used for clamping cables running along walls, ceilings, structures, etc. at 750mm interval.
- (f) The armour and semi-conducting screen of single core cables shall be earthed at one end. The continuity of armour and semi conducting screen shall not be broken at each joint. The unearthed end of armour and screen shall be insulated.

8.9. Earthing

- (a) Metallic sheaths, screens and armour of all multi-core cables shall be earthed at both equipment and switchgear end.
- (b) Sheath and armour of single core power cables shall be earthed at switchgear end only. For long lengths of cables multiple earthing may have to be adopted to safeguard against the presence of standing voltages under normal as well as fault conditions by providing sheath interrupter.

9. FIRE-PROOF SEALING OF CABLE PENETRATION

9.1. Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. **The** fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to the following requirements:

- (a) FPSS shall have a fire rating of two hours.
- (b) The FPSS shall be subjected to fire endurance test, hose stream test, temperature measurement of non-flaming side as per ASTM-E119. 'Standard method of fire tests of building construction and materials'.
- (c) The FPSS will also conform to the in-combustibility test carried out in accordance with IS: 3144-1992.
- (d) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.
- (e) FPSS shall have life of 25 years.

9.2. Fire Stop/Seal

The FPS system adopted for cables or cable trays penetrating through walls and floor openings, or cables passing through embedded conduits/pipes/ pipe-sleeves, constitutes a 'fire stop/seal', which is meant to prevent spreading of fire between areas separated by fire-resistant barriers.

Performance Requirements

(i) Requirement of fire stops

- The material, design and construction of the fire stops shall be such as to provide the fire-rating of 120 minutes for a fire on any side and meet all requirements listed in this specification and the relevant codes and standards.
- The materials used in the fire stops shall be non-hygroscopic, compatible with the type of cables.
- The fire stops shall be suitable for retrofitting of cables through the penetration seal without disturbing the sealing of the cables already existing.

(ii) Requirements of fire breaks

- Each firebreak shall have a fire-rating of 30 minutes and shall be capable of withstanding for the duration specified a fire on any side of the fire break.

9.3. Application of fire proof sealing system

(i) Fire stops

Fire stops shall be provided for cable penetration openings listed below

- The passage of cables/cable trays pipe sleeves/embedded conduits through walls / floors.
- Vertical raceways, which carry cables between successive floors, through openings provided in the RCC floor slab, shall be sealed by fire stops at each floor level.
- Cable entry through openings in floor slabs below HT/LT switchgear, MCCs, various control and relay panels and other bottom entry panels, shall be effectively sealed by fire stops.

(ii) Location of fire breaks



- Firebreaks shall be provided on both cable rack and trenches at all cable tray intersections and tee-offs.
- On linear runs of cable trays between fire stops or fire breaks, fire breaks shall be provided at intervals of 15 metres on horizontal cable runs and 5 m on vertical cable runs.
- Fire breaks in linear runs of cable trenches between intersections and tee-offs shall be provided at intervals of 30 metres.

9.4. Bidder shall furnish the test certificates for the fire stops and fire breaks after award of contract for Owner / Owner's Representative review. If the **certificates** are not satisfactory all the tests shall be conducted free of cost. The offered system i.e. fire stops and fire breaks shall be identical (or better) with the system which is successfully type tested for the specified rating i.e. the composition density of the material, thickness of coating in case of fire breaks and any other properties of the material / system offered shall be identical or better than the tested system and shall be subject to Owner / Owner's Representative approval.

9.5. Performance Tests: Tests on Fire Stops

(a) The fire stops shall be subjected to the following type tests:

- (i) Fire Rating Test
- (ii) Hose Stream Test

(b) Type tests shall be conducted on different fire stop test specimens described above as per IEEE-634. The sizes of the fire stop test specimens, shall be similar to the largest of the sizes being used in the plant.

(c) Preconditioning of fire stop test specimens

Before conducting the fire rating and hose stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.

(d) Test on Fire Stops

During the fire rating test, the transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self ignition temperature of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, with a maximum temperature limit on the unexposed surface of 200°C.

(e) Tests on fire breaks

Firebreaks shall undergo the following tests as per ANSI-IEEE-383:

- (i) Ampacity test
- (ii) Flame test

9.6. FIRE BREAK

- a) Fire break shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of two hours.
- b) Fire break shall be provided at an interval of 15 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with fire breaks. Fire coating shall be provided on entire length of cables in lignite handling system.
- c) When pipe sleeves are provided for cables from outdoor areas to indoor areas, the pipe opening at the outdoor side shall be sealed by fire proof sealing material which is also continuously water proof. Water should not enter through any pipe sleeves from outside area to any MCC room, control room etc. The indoor side of the pipe opening shall also be sealed by continuous fire proof sealing materials. The duct banks in outdoor areas also need to be sealed by water proof seals. It is necessary to explore possibility of applying waterproof coating on fireproof sealing in the form of water-proof barrier wall if suitable.

10. TESTS

- 10.1.** All routine tests, acceptances tests and FRLS tests as per relevant standard shall be performed on each size of cable at works/ factory. If same size is supplied in different lots, inspection shall be done for each lot. If same cable is supplied by different agencies, test shall be carried out on cables supplied by each agency. These tests shall be carried out as per relevant standards as applicable.

Routine and acceptance test shall be carried out on FPSS.

10.2. Testing and commissioning of cables

- (a) Cables shall be checked for insulation resistance before and after jointing.
- (b) High voltage testing

All cables of 1.1 kV grade 400 mm² and above and all HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 4 in IS : 1255.



- c) Type test certificates for each type & size of the cable supplied by the Bidder shall be submitted. In case Type test certificate for similar type & size is not available or the same is older than 05 years, the same shall be conducted in presence of Owner or his representative.

TECHNICAL DATA SHEET – CABLES

TECHNICAL DATA

The Bidder shall indicate the following for each type and size of cables:

1	Make	:	
2	Type	:	
3	Applicable Standard	:	
4	Voltage Grade	:	
5	Suitable for system with		
	a Service voltage	:	
	b Neutral earthing	:	
6	Maximum conductor temperature		
	a Continuous, °C	:	
	b Short time, °C	:	
7	Conductor		
	a Material	:	
	b Size, mm ²	:	
8	Shielding on Conductor (HT Cables)		
	a Material	:	
	b Type		
	c Thickness, mm	:	
	d Whether extruded	:	Yes / No
9	Insulation		
	a Material	:	
	b Type		
	c Thickness, mm	:	
10	Shielding on insulation (HT cables and instrumentation cables)		
	a Material	:	
	b Type		
	c Thickness, mm	:	
11	Inner sheath		
	a Material	:	
	b Type		
	c Thickness, mm	:	
	d Extruded?	:	Yes / No
	e Approx. outside dia over sheath, mm	:	



12	Armouring		
	a Material	:	
	b Size, No. x dia		
	c D.C Resistance at 20°C, Ohm / km	:	
13	Outer sheath		
	a Material	:	
	b Type		
	c Thickness, mm	:	
14	Approximate overall diameter, mm	:	
15	Standard drum length with tolerance, mm	:	
16	Net weight of cables, kg/km	:	
17	Continuous current rating for standard IS condition laid direct		
	a In ground	:	
	B In duct	:	
	c In air	:	
18	a Short circuit current for 1 sec., kA	:	
	b Conductor temperature allowed for the short circuit duty	:	
19	Electrical parameters at maximum operating temperature, i.e. 90°C for HT power, 85°C for LT power, 70°C for Control cables and 85°C for instrumentation cables.		
	a Conductor resistance, Ohm / km	:	
	b Insulation resistance, Ohm / km	:	
	c Reactance at 50 Hz, Ohm / km	:	
	d Impedance, Ohm / km	:	
	e Image attenuation (instrumentation cables)	:	
	f Cross talk attenuation (Instrumentation cables)	:	
20	Recommended minimum bending radius	:	
21	Derating factor for following ambient temperature in Air/Ground		
	• At 30°C	:	
	• At 35°C	:	
	• At 40°C	:	
	• At 45°C	:	
	• At 50°C	:	
22	Group factor for following nos. of cables laid touching / 2 x diameter centre to centre apart		
	a Single core cable (in trefoil)	:	
	i. 2 nos.	:	



	ii. 3 nos.	:	
	iii 4 nos.	:	
	b Multicore cable (in trefoil)	:	
	i. 3 nos.	:	
	ii. 4 nos.	:	
	iii 5 nos.	:	
	iv 6 Nos.	:	
23	Single line to ground fault current withstand capability of screen (HT cables)	:	
24	Single line to ground fault current withstand capability of armour (HT cables)		
25	The cables shall be tested as specified	:	
26	Whether type test certificates for similar type of cables enclosed with the Bid?	:	Yes / No
27	Cable sectional details submitted?	:	Yes / No

4.10. TECHNICAL SPECIFICATIONS FOR VFD

1. Specific Requirements

- 1.1 The LT variable frequency drives shall be provided for any equipment as per system requirement with due approval from Owner / Engineer. The scope shall also include Transformers required for the system, cables, panels etc., with air conditioning for the panel room.
- 1.2 The following paragraphs define the requirements of variable speed drives (VFD) for LT motor.
- 1.3 The VFD shall be of fixed DC bus type with a full wave diode bridge input. The VFD shall convert three phase, 50 Hz input power to three phase adjustable voltage, adjustable frequency output power using Pulse Width Modulation (PWM) switching techniques and Insulated Gate Bi-Polar Transistors (IGBTs). VFD shall employ sine wave PWM control and shall be able to directly control the current (or torque) of an induction motor utilizing a magnetic flux observer principle. Each inverter panel shall be connected to AC squirrel cage induction motor, which drives the ID Fan and shall control speed/torque by varying the stator voltage and frequency.
- 1.4 The VFD shall be capable of operating any standard squirrel cage induction motor with a full load current rating equal to or less than the full load current rating of the VFD. At any time in the future, it shall be possible to install a new or rewound standard squirrel cage induction motor with a full load current rating equal to or less than the full load current rating of the VFD without making any modification to the VFD. VFD shall be designed for the next higher rating available above motor FLC rating.



- 1.5 The inverter units shall be microprocessor based and shall be suitable for the site ambient conditions. The complete VFD system shall be designed to run at 50 deg C Ambient Temperature. Necessary deration shall be taken into account for this.
- 1.6 The Control Card CPU shall be 32 bit processor. The converter section shall consist of full wave diode bridge rectifier of necessary rating. 18-pulse rectification configuration scheme shall be provided to limit the harmonics as specified in IEEE 519. For multi-level cascaded technology automatic power bypass facility with neutral shifting is compulsory. The VFD shall necessarily employ either AC or DC reactors at the input side for limiting the harmonics. The inverter section shall be IGBT based only.
- 1.7 The input AC supply is at 415 V, 3 phase, 50 Hz and the nominal variations in voltage and frequency are $\pm 10\%$ and $\pm 5\%$ respectively with combined voltage and frequency variation of 10%. The squirrel cage motors shall be rated for operation on this system. Offered VFD model shall be able to handle voltages with fluctuations as mentioned.
- 1.8 Motor and VFD shall withstand the voltage and torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of the rated voltage during fast changeover of buses. The VFD shall have auto-speed search (fly catcher) for starting into rotating load. The VFD must be able to catch the motor spinning and bring to the desired operating speed in the proper direction without stopping the motor or tripping the drive.
- 1.9 The VFD shall be able to deliver motor rated current continuously and shall be able to deliver Class II duty overload as per IEC 60146-1 standard i.e. 150% of motor rated current for 60 secs, at 50 deg. C temperature. Necessary deration, if required, to be taken into account to meet overloads requirements. Necessary calculations to arrive at the current rating of the VFD shall be furnished.
- 1.10 Input Power Factor (not the fundamental Power factor) shall be greater than 0.93 at 100% load and rated speed and overall efficiency of the system shall be greater than 95% including input transformer. The transformer shall be of converter duty type.
- 1.11 Depending on the distance between the VFD and the motor, the VFD system shall consist of appropriate protection device at output of the inverter (e.g. output reactor/filter) to safeguard motor against voltage spikes. Surge arrester should be provided to input transformer to take care of high voltage spikes.
- 1.12 The inverter shall be designed to withstand momentary dips of about 35% in supply voltage for 3 cycles without damage to semi-conductor components or blowing of fuses. Power loss ride through feature for 2 secs shall be provided.
- 1.13 The VFD shall be provided with Metal Oxide Varistors (MOVs) if required for transient voltage suppression on all three phases of the incoming



power line. The VFD shall protect itself from damage due to any grounding or shorting of its output power circuit.

- 1.14 The Drive should be True 415V Low Voltage drive. Filters and harmonic filters if required as per design philosophy then the same shall be provided as per OEM standard design.

2. Controls and Monitoring

- 2.1 VFD shall be with an interactive and user-friendly digital operator interface with LCD display and sealed membrane type keypad. The operator interface shall be used for drive programming, drive monitoring and drive trouble shooting. The operator interface must also be able to start and stop the drive, reset VFD faults and manually adjust the VFD's speed reference. The operator interface shall have LED indicators for drive fault, drive run, drive in current limit and forward direction of rotation. The digital operator shall allow simple monitoring of inverter operating conditions including speed, current, voltage, torque, power etc. Messages shall be Alpha numeric in nature. All the fault messages shall be in clear English language and display of error codes are not acceptable. The operator interface shall be removable and remote mountable.

- 2.2 Following protections shall be built in within the inverter.

- a. Motor Overload / Over Torque
- b. Instantaneous Over current (This device shall monitor the peak output current continuously and shall provide instantaneous shutdown without component failure whenever its trip point is surpassed. The trip point must be greater than or equal to 250% of the VFD's rated full load output current)
- c. Ground Fault
- d. Over Voltage/Under Voltage
- e. Output Short Circuit
- f. Output Phase Loss/Fuse Failure
- g. Phase Sequence Protection
- h. Input Phase Loss/Single Phasing Preventer
- i. Over Speed
- j. Heat Sink Over temperature/VFD Panel Temperature High
- k. Stall prevention (During acceleration, deceleration and constant speed operation)
- l. Dv/dt Protection
- m. Techo Generator specification for RPM feedback if require during DEE.



- 2.3 The operator interface shall be able to display all real time operating variables and all drive programming parameters. The operator interface shall be capable of displaying a specific user selected parameter on power-up. This power-up parameter would typically be a parameter that is important to the operator such as motor speed or motor load. All VFD operating parameters shall be stored in non-volatile memory (EEPROM).
- 2.4 The drive shall have built in monitoring of following parameters as minimum on its digital operator interface:
- a. Output Frequency
 - b. Output Current
 - c. Motor Speed
 - d. Output Voltage
 - e. DC Bus Voltage
 - f. Output Power (It shall be possible to display power output of the drive in KW and the accumulated power output over the time (kWhr)
 - g. Torque
 - h. Digital Input Status
 - i. Digital Output Status
 - j. Analog Input Status
 - k. Air intake temperature
 - l. Power unit temperature
 - m. Necessary transducers shall be provided with 4-20 mA output for indicating motor speed and current in the DCS
 - n. The following indications shall also be provided
 - Motor Running
 - Motor Stopped/Tripped
 - AC Mains "On"
 - System "Ready to Start"
 - VFD System Trouble/Fault
- 2.5 On occurrence of fault, the VFD shall store the status of all the above parameters prevailing at the time of fault occurrence for fault diagnosis. The VFD shall store fault logs of minimum last 6 faults in memory.
- 2.6 Drive output voltage shall vary with frequency to maintain a constant volts per hertz ratio up to the motor base speed corresponding to 50Hz. The drive shall have fifteen (15) or more built in V/F patterns along with a user definable custom V/F pattern.
- 2.7 The VFD shall include sensor less AC vector control with automatic tuning for the speed loop and current loop. The output frequency resolution shall be 0.001 Hz and the VFD shall be capable of maintaining motor speed



- within + 0.5% of maximum speed without the use of a motor mounted encoder or tachometer. VFD tuning shall be completely automatic (it must not require user participation during start-up).
- 2.8 Auto-manual selector switch shall be provided for set point. In auto position, it should accept 4 – 20 mA external signal from Plant DCS and in manual position, the control shall be from the digital reference of the panel. Local/Remote selector switch shall be provided to allow the operator to select where the VFD start/stop command will come from. In “local” mode, the command will come from local start/stop push buttons and in “remote” mode, the command will come from DCS.
- 2.9 The VFD shall protect against damage due to any interruption or run away of its incoming speed reference signal. If the speed reference signal is a 4–20 mA current reference, it shall be possible to program the VFD to either shutdown, go to minimum speed or continue operation at its last known speed reference point whenever a loss of reference signal is detected.
- 2.10 VFD shall have the following features :
- a. Adjustable motor overload feature
 - b. Torque limits and acceleration & deceleration ramps shall be field adjustable
 - c. Multi function and user programmable I/O's (User programmable digital inputs, digital outputs, analog inputs and analog outputs as required shall be provided. The VFD shall have eight (8) user programmable preset speeds.)
 - d. Selectable reverse run prohibition
 - e. Settable minimum and maximum operating frequency
- 2.11 The interface details of VFD shall be incorporated as required for control, feedback, annunciation etc with DCS system will be hardwired only. Necessary hardware shall be included in the scope of the bidder.
- 2.12 All the necessary interfaces required between the VFD and the plant DCS system and all interfaces required between the VFD and the plant electrical system will be hardwired only and same to be included in the Bidder's scope.

3. Cubicle Construction

- 3.1. The VFD system shall be designed for continuous operation at site ambient conditions either with natural cooling or forced air cooling. If forced air cooling is adopted, same shall be with low noise ventilation fans at the top of the cubicle, which shall suck air through the thyristor modules. The arrangement shall be, preferable such that, ventilation air passes only through thyristor heat sinks in a separate duct. This prevents dust deposition and consequent tracking. Suitable thermal relays for exit air temperature monitoring and control shall also be incorporated.



- 3.2. Panels shall be free standing, floor mounting type and shall comprise rigid welded structural frames enclosed completely with sheet steel enclosure of thickness 2 mm minimum cold rolled for load bearing and 1.6 mm for other members. The panels shall be designed so as to have low Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) and shall provide maximum physical protection for all internally mounted components. The cubicles shall conform to IP 42 degree of protection.
- 3.3. Separate cubicles shall be provided for incoming breaker and transformers.
- 3.4. All doors, removable covers and panels shall be gasketed all round with neoprene gaskets. Ventilating louvers shall have screens and filters. The screens shall be made of either brass or GI wire mesh.
- 3.5. The VFD shall include a door interlocked input AC line disconnect switch with fuses. The fuses should be of semiconductor type and have as asymmetrical short circuit interrupting capability of 200 kA.

4. Bypass Facility

- 4.1. By-pass facility to operate the motor direct-on-line shall be provided. Inverter panel shall be equipped with by-pass facilities, so that, the motor may be operated as a fixed speed motor, if required.
- 4.2. The by-pass equipment shall be mounted in a cubicle separate from the inverter panel and shall be so arranged that, the inverter panel can be electrically isolated from the by-pass equipment. This will enable it to be maintained or repaired safely, while the motor is running in by-pass mode.
- 4.3. It is essential, when operating in by-pass, that all interlocking and control circuits remain operative.

5. VFD system includes the following:

- a) VFD panel includes incoming, outgoing and bypass arrangements
 - b) Laptop, required licence software & communication cable suitable for communication with drive controls
 - c) Mandatory spares
- 5.1. Before finalization of rating of VFD drive, approval from Owner / Owner's Engineer is required.
 - 5.2. VFD panels shall be installed inside complete air-conditioned environment and temperature of VFD room shall be maintained less than 23°C when all the VFD are running on full load. Bidder shall install and commission the required number of Ductable air conditioner of suitable capacity in order to achieve desired ambient conditions of VFD room at full load condition.
 - 5.3. One group alarm for VFD shall be provided at plant control room.
 - 5.4. The interface details of VFD by-pass breaker shall be incorporated as required for control, feedback, annunciation etc with DCS system will be hardwired only. Necessary hardware shall be included in the scope of the bidder.



- 5.5. All the necessary interfaces required between the VFD by-pass breaker and the plant DCS system and all interfaces required between the VFD and the plant electrical system will be hardwired only and same to be included in the Bidder's scope.

6. Tests

All Routine and Acceptance tests for all the components shall be carried out as per relevant standards. Type test certificates for similar equipment supplied by the Bidder shall be submitted. In case Type test certificate for similar equipment is not available, the same shall be conducted in presence of Owner.

7. Technical Particulars

The VFD and accessories shall comply with the particulars as per the technical requirements specified below and Bidder shall furnish particulars called for in respective columns given below.

Sl. No.	Description	Unit	Specification Requirement	Bidder 's Details
1.	Type of drive		Inverter (IGBT based PWM controlled) AC drives	
2.	Manufacturer		SIEMENS / HITACHI / AMTECH	
3.	Application		*	
4.	Type of motor		Squirrel cage induction motor	
5.	Rating of drive	kW	*	
6.	Quantity		*	
7.	Rated power factor		*	
8.	Efficiency		*	
9.	Rated output voltage	kV	415 V	
10.	Full load current	kA	*	
11.	Type of duty		a) 100% continuous b) 150% overload for 1 minute in 24 hours	

Sl. No.	Description	Unit	Specification Requirement	Bidder 's Details
12.	Quadrants of operation		*	
13.	Power supply systems			
	a)Input power supply		415V, 3ph, 50Hz	
	b)Variation in voltage		±10%	
	c)Variation in frequency		±5%	
	d)Combined voltage & frequency variations		10%	
	e)System fault level	kA, sec	40kA (rms) for 1 sec	
	f)Type of earthing		Non-effectively earthed system	
14.	Location		Indoor	
15.	Type of cooling		*	
16.	Input and output cables			
	a) Size and type		*	
	b) Entry		Bottom	
17.	Dimensions		*	
18.	Degree of Protection		IP 42	
19.	Power loss ride through time	sec	2	
20.	Control characteristics			
	a) Control Method		Drive level control using digital system	
	b) Output freq. range		*	
	c) Frequency accuracy		0.01%	
	d) Frequency resolution	Hz	0.001	
	e) Speed regulation		0.5% of max speed	
	f) Speed range		*	
	g)Accelerate/decelerate time		*	
21.	Harmonic limitations			



Sl. No.	Description	Unit	Specification Requirement	Bidder 's Details
	I) Voltage harmonics			
	a) Source side		Maximum 5%	
	b) Load side		Maximum 5%	
	II) Current Harmonics			
	a) Source side			
22.	i) 5th		Maximum 30%	
	ii) 7th		Maximum 20%	
	iii) 11th		Maximum 10%	
23.	Miscellaneous			
	a) Soft-start		Yes	
	b) Flying restart		Yes	
	c) Auto restart		Yes	
24.	Kinetic buffering		Yes (Preferably for a back up time of 2 sec.)	
Note	*** indicated above shall be filled by the Bidder.			
	*** Bidder shall furnish the data after placement of order.			

8. Data to be furnished with the Bid

- 8.1. Detailed description of VFD and accessories.
- 8.2. Descriptive literature/pamphlets on various subsystems of VFD giving details of principles of operation.
- 8.3. General arrangement drawings showing outline dimensions.



SECTION-5 GUIDELINES FOR INSTALLATION OF ELECTRICAL EQUIPMENT

1. GUIDELINES FOR INSTALLATION OF ELECTRICAL EQUIPMENT

All electrical equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, and squat and properly aligned and oriented. Tolerances shall be as established in the Manufacturer's drawings and statutory requirements. Bidder shall prepare detail QAP using SOP for erection/preservation/ testing/ commissioning of all electrical equipments considering relevant standards, best engineering practices and OEM guidelines and submit to Owner for approval. Bidder shall have to submit details list of tools and tackle required for erection / preservation / testing / commissioning of all the electrical equipments considering relevant standards, best engineering and industrial practices, and OEM guidelines and submit to Owner for approval before mobilisation for ETC. Bidder shall have to submit work completion schedule with microline planning for all major electrical equipments for Owner approval. However, following are the minimum requirements.

1.1. Transformers

Proper arrangement shall be provided for transformer unloading and handling at site before final erection as per OEM guidelines and relevant standards. Proper weather proof arrangement shall be provided for storage of all the accessories of transformer. Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hoses shall not be used. Circulation and filtering of oil, heating of oil by regulated short circuit current during drying runs and sampling and testing of oil shall be in accordance with the Manufacturer's instructions and specified Code of Practice.

1.2. Switchgear, Control/ Relay Panels

Switchgears and control relay panels/desks shall be installed in accordance with specified code of practice and the Manufacturer's instructions. Proper weather proof arrangement shall be provided for storage of all the switchgears, control / relay panels at site as per OEM guideline and relevant standards.



In joining shipping sections of the switchgear/panels/control centres together, adjacent housing or panel sections provided shall be bolted together after alignment has been completed.

1.3. Motors

The installation, testing, commissioning of the motors shall be as per the applicable code of practice and the Manufacturer's instructions.

1.4. Battery and chargers

Each cell of the battery bank shall be inspected for breakage and condition of cover seals as soon as received at site. Battery and chargers shall be installed as per guideline and supervision of OEM. Each cell shall be filled with electrolyte in accordance with the Manufacturers instructions in presence of OEM. Battery shall be set up on racks as soon as possible after receipt, utilising lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals.

2. TESTING AND COMMISSIONING

- a) Test of all equipment shall be conducted as per latest IS. Tests shall also confirm to International Standards IEC / VDE / DIN / BS.
- b) Routine tests and Type tests shall be conducted as given in relevant chapters of Electrical Volume III (1 OF 3).
- c) The site tests and acceptance tests to be performed by Bidder are detailed below.
- d) The bidder shall be responsible for satisfactorily working of complete integrated system and guaranteed performance. Field quality plan related to field erection, testing & commissioning shall be submitted for Owner / Engineer approval. For power transformer, tan delta test, SFRA (sweep frequency response analysis) test, DIRANA testing shall also be conducted at site before charging over and above BDV, PPM & DGA analysis of transformer oil before charging and after charging. For generator, tan delta test, ELCID test on generator stator and RSO test / rotor inter turn fault by dynamic wave method on generator rotor shall also be included in SITE test.

2.1. All **equipment** for testing and commissioning shall be calibrated by authorized third party & calibration shall be valid at time of testing.

2.2. The BIDDER shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of the **interconnections** between various items of the equipment. This shall be done by applying



normal AC or DC voltage to the circuits and operating the equipment for functional checking of all control circuits, e.g., closing, tripping, control interlock, supervision and alarm circuits. All connections in the switchgear shall be tested from point to point for possible grounds or short circuit.

2.3. Insulation resistance tests shall be carried out by following rating meggers :

- | | | |
|-----|--|--------------------------------------|
| (a) | Control circuits upto 220V | : By 500 V megger |
| (b) | Power circuits, bus bars,
connections upto 11kV | : By 1000V megger |
| (c) | Power circuits, bus bars,
connections above 11 kV | : By 5000 V motor
operated megger |

2.4. In order to avoid hazards to personnel moving around the equipment **such** as switchgear etc. Which is kept charged after installation before commissioning, such equipment shall be suitably cordoned off to prevent any one accidentally going near it.

2.5. The BIDDER shall possess or obtain valid working license from the **concerned** State Electricity Authority/Inspectorate for carrying out electrical **installation** work in the region before commencing the work.

2.6. Sufficient nos. of tools and tackles required for the testing and commissioning of the complete system, as per relevant standards shall be in the scope.

3. SITE TESTS AND CHECKS

General

- a) All the equipments shall be tested at site to know their condition and to prove suitability for required performance.
- b) The test indicated in following pages shall be conducted after installation. All tools, accessories and required instruments shall have to be arranged by Bidder. Any other test which is considered necessary by the manufacturer of the equipment, Bidder or mentioned in commissioning manual has to be conducted at site.
- c) In addition to tests on individual equipment some tests / checks are to be conducted / observed from overall system point of view. Such checks are highlighted under miscellaneous tests but these shall not be limited to as indicated and shall be finalised with consultation of client before charging of the system.



- d) The Bidder shall be responsible for satisfactory working of complete integrated system and guaranteed performance.
- e) All checks and tests shall be conducted as per OEM requirements, approved by Owner/ Engineer in the presence of Owner / Engineer and test results shall be submitted in six copies to Owner and three copies to Electrical Inspector. Test results shall be filled in proper Performa.
- f) Testing formats and procedures and protocols shall be submitted prior to commencement of testing three weeks in advance for all the electrical equipments at the time of commissioning to Owner / Engineer for approval.
- g) Testing of tariff metering CTs and PTs shall be carried out at ERDA or any government approved NABL testing lab as per state grid authority rules in presence of state grid authority / Owner / Engineer and submit to state grid authority / Owner / Engineer for approval before charging, also included in the scope of Bidder.
- h) After clearance from Electrical Inspector system / equipment shall be charged in step by step method.
- i) Based on the test results clear cut observation shall be indicated by testing engineer with regard to suitability for charging of the equipment or reasons for not charging are to be brought by the Bidder.

Trial Run Test

After the successful test of each equipment as per standard test procedure the entire control system shall be put on trial run test on actual site conditions and operation of the system.

Acceptance Test

The acceptance test on the system shall be carried out by the Bidder as per mutually agreed test procedures to establish satisfactorily functioning of the system as a whole and each equipment as part of the system.

	<u>SITE TESTS</u>
	Site tests shall include all tests to be carried out at site on various equipment. They shall include but not be limited to calibration tests, configuration tests and commissioning tests. The Bidder shall be responsible for all site/commissioning tests. All necessary testing equipment required for erection, testing and commissioning shall be arranged by the Bidder. Bidder shall furnish detailed Field quality

	plans including commissioning check lists along with procedures and formats for recording of the tests for all individual equipment for Owner's review/approval. The tests to be carried out on the equipment at pre-commissioning stage shall include following but not limited to that indicated below. Site tests indicated in respective equipment sections are also included.
1	Transformer
1.1	Before starting erection, thorough internal inspection of transformer shall be carried out by engineer along with OEM representative at site. OEM engineer is required at site for monitoring erection, testing and commissioning activities Measurement of safety clearances IR test on each winding to ground and between winding.
1.2	Turns ratio test on each tap
1.3	Polarity and vector group test Floating neutral point measurement
1.4	Measurement of winding resistance for HV at all taps and also for LV winding.
1.5	IR, wiring and operational tests on all control devices in control cabinet, winding temperature indicators, etc.
1.6	Checking of earthing wrt transformer tank (flexible from top cover to tank) other parts, neutrals.
1.7	Check insulators for cracks.
1.8	Measurement of magnetising current and no load loss.
1.9	Measurement of PI value.
1.10	Conducting magnetic balance test
1.11	Testing of Buchholtz relay for alarm and trip conditions
1.12	Testing of Pressure Relief Valve for trip contacts
1.13	Checking of OTI/WTI temperature contacts for the settings and healthiness of alarm & trip contacts
1.14	Checking for magnetic oil level gauge for the mercury contacts, Oil leakages and arresting of oil leakages (if there)
1.15	For power transformer, capacitance and tan delta test on windings, SFRA (sweep frequency response analysis) test, DIRANA testing shall also be conducted at site before charging.
1.16	Checking of operation of all valves and ensure their close / open positions.
1.17	Filtration of oil by using oil filters m/c for improving IR value of Transformer or improving Transformer Oil Value for water ppm, BDV if required only.



1.18	BDV test & DGA on Oil samples from top & bottom before charging and after charging also
1.19	Checking of Oil for acidity, water content and tan delta as per IS 335.
1.20	Checking of other points given in manufacturer's commissioning manuals.
1.21	DGA, BDV and water ppm for oil shall be carried out in interval of every 3-months after charging of power transformer up to plant COD shall be included in the scope of Bidder. a) SFRA test each tap on each power transformer shall be carried out. b) Tests on bushing current transformer c) Core insulation testing d) Protection system functional testing e) Stability of Differential protection testing f) REF protection testing by primary injection and secondary injection method g) Thermo-vision scanning post energization up to full load of unit h) Short circuit impedance testing at principal and extreme taps i) Frequency domain spectrometry of bushings j) Partial discharge measurement k) Polarization Index testing
2	Current Transformer
2.1	IR test on each winding, winding to earth and between windings.
2.2	Checking of winding ratios by primary injection set and phase angle testing
2.3	Polarity check on each winding
2.4	Continuity check for all windings
2.5	Check for connections to correct taps.
2.6	Testing of CT polarity and CT ratio by primary injection test and CT characteristics
2.7	Measurement of knee point voltage and secondary winding resistance for the CTs used for differential protection.
2.8	Checking of continuity and IR values for cables from CT to Marsh Box.
2.9	Checking tightness of earthing connections.
2.10	Checking of insulator for cracks. Magnetization curve (Excitation) testing Secondary burden tests
2.11	Check output after loading of the main circuit.
2.12	Tan Delta and capacitance measurement for CTs. Oil BDV and moisture content testing



3	Potential Transformer
3.1	IR test of primary winding by HV megger between windings and earth.
3.2	IR test of primary winding by LV megger between windings and winding to earth.
3.3	Checking of voltage ratio and phase angle error testing
3.4	Verification of terminal markings and polarity.
3.5	Checking of continuity and IR values for cables from PT to Marsh Box.
3.6	Checking tightness of earthing connections
3.7	Checking of insulator for cracks. Ferro-Resonance testing
3.8	Check output on charging of the system with connected meters / relays Tan Delta and capacitance measurement for PTs
4	NGR
4.1	Measurement of resistance.
4.2	IR test by HV megger between terminal and earth.
4.3	Checking of earth connection for terminal and for body. Check for minor damages and cracks in supporting insulators after cleaning
4.4	Check for isolator operation and continuity of aux. contacts (if applicable).
4.5	Check for temp. rise of enclosure and current flow in the resistances.
5	HT Switchgear
5.1	IR test.
5.2	HV one minute P.F test for busbar and CTs.
5.3	Measurement of contact resistance for HT breakers.
5.4	Checking the healthiness of poles & Vacuum bottles
5.5	Test to prove inter changeability of similar parts (including breaker module).
5.6	Testing of relays as per supplier's commissioning manual.
5.7	Testing and calibration of all meters and transducers.
5.8	Operation of all relays by secondary injection.
5.9	Testing of CT polarities and CT ratio by primary injection test and CT characteristics.
5.10	Measurement of kneepoint voltage and secondary resistance for CTs used for differential protection.
5.11	IR and voltage ratio test for PTs.
5.12	Functional test of all circuit components for each panel / feeder.
5.13	Test to prove closing / tripping operation at minimum and maximum specified voltage in test and service position and also measurement of time for above operation.



5.14	Circuit breaker timing and operational checks		
5.15	Functional interlock testing		
6	LT Switchgear / MCC		
6.1	IR test before and after HV test.		
6.2	HV test with 2.5 kV megger		
6.3	Functional test for all feeders		
6.4	Testing and calibration of all meters and transducers.		
6.5	Checking and calibration of overload relays and protective relays as per supplier commissioning manuals.		
6.6	Check operation of contactors from local and remote points.		
6.7	Checking of interlockings between incomers / bus coupler and other feeders.		
6.8	Test to prove interchangeability of similar parts.		
6.9	Tests to prove correct operation of breakers at minimum and maximum specified control voltages.		
6.10	Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.		
6.11	Checking of earthing connection for neutral earth bus, cable armour location of E/F CT etc., as per the scheme.		
6.12	Check test, services and draw out position of all the breakers and operations of mechanical flag indicators and electrical indication lamps.		
6.13	Check functioning of various electrical schemes like auto changeover signalling etc.		
6.14	Contact pressure test.		
6.15	Testing of CT as per CT testing details enclosed in SI. No.2		
6.16	Breaker	:	IR value checking with breaker ON Phase to phase & phase to earth and between phases in off position.
7	ACDB / DCDB / MLDB etc.		
7.1	IR test before and after HT test.		
7.2	HV test by HV megger.		
7.3	Checking for functions of components for each module. MCCBs and MCBs testing as per OEM guideline.		
7.4	Checking for interchangeability of similar components.		
7.5	Checking of tightness of earth connection.		
7.6	Testing and calibration of all indicating meters.		
7.7	Check output of each feeder after energisation.		
8	AC Motors		



8.1	IR test of stator and rotor windings. Polarization index testing
8.2	Heating of both windings upto the permissible temp. limit from heating curve (only for HT motors).
8.3	Ensure that checking / testing of associated switchboard, cables, relays / meter interlockings as mentioned in relevant chapters are completed.
8.4	Check tightness of cable connection.
8.5	Winding resistance measurement of stator and rotor.
8.6	Checking continuity of winding.
8.7	Check tightness of earth connections.
8.8	Check space heaters and carryout heating of winding (if required).
8.9	Check direction of rotation in decoupled condition during Rick start.
8.10	Measure no load current for all phases.
8.11	Measurement of temperature of body during No-load and load conditions.
8.12	Check for tripping of motor from local / remote switches and from electrical / technological protection including differential protection.
8.13	Checking of vibration (if required)
8.14	Checking of noise level (if required).
8.15	During load running, measurement of stator and bearing temperatures (if applicable) for every half an hour interval till saturation comes.
8.16	Checking tightness of foundation bolts.
8.17	Check operation of speed switch (if there).
8.18	Check continuity of temp. detectors. Testing and calibration of all temp. detectors.
8.19	Check alignment, paralleling of shafts, level of lubricating oil, lubricating oil pressure etc. as per manufacturer's manual.
8.20	Check contact of slip ring brush and measure brush pressure (150-200 gm/sq.cm).
8.21	For CACW drive check cooling water and system / piping, availability of pressure cleaning and pressure testing of pipelines etc.
8.22	Check for polarisation index of stator windings R10 / R1 by motorised megger. (The value should not be less than 2.0). R60/R10 absorbtion co-efficient shall not be less than 1.5
8.23	Dielectric test (only for HT motors).
8.24	HV testing for HT motors
8.25	Bearing insulation resistance testing
8.26	Vibration measurement and winding / bearing temperature checks
8.27	Measurement of open circuit rotor winding voltage for slip ring motor.

8.28	For actuator drives following shall be checked / tested.
	a) Visual and dimensional
	b) Hydraulic pressure for valves
	c) IR and operation of limit switches
	d) Winding resistance and IR
9	Battery
9.1	Checking for completion of civil / ventilation requirement of battery room.
9.2	Checking of adequacy of charger output / requirement wrt current required for battery charging as per the manual.
9.3	Check availability of safety devices, water and first aid box.
9.4	Check polarity of connections between battery and charger.
9.5	Visual inspection test for level and leakages.
9.6	Checking of layout as per approval drawing.
9.7	Checking of IR value from positive to earth and negative to earth.
9.8	Checking of specific gravity & voltage per cell and total voltage between positive negative and earth to positive / negative and also tap cell voltage (as applicable) every month after initial charging up to COD operation.
9.9	Checking of tightness of connectors on each cell.
9.10	Checking of capacity test and hourly measurement of specific gravity and voltage for each cell.
9.11	Internal resistance / impedance testing
10	Battery Charger
10.1	IR test
10.2	HV test
10.3	Checking voltage ratio of boost and float mode transformers.
10.4	Checking for charging mode of batteries constant current and constant voltage mode.
10.5	Load test on chargers by running of DC drives, resistors bank and by liquid resistance system.
10.6	Checking of tightness of earthing connections.
10.7	Check for all alarm conditions.
10.8	Checking and calibration of all indicating meters and transducers..
10.9	Check functional operation of charger, auto / manual change over from float to boost and boost to float etc.
10.10	Checking and setting of all relays.
10.11	Check AC ripple in boost and float mode after charging.



10.12	Check polarity of cables connected to battery. Checking of smooth change over from charger to battery after AC supply failure.
10.13	Current limit / overvoltage protection testing
10.14	Checking of balance firing of all thyristors
11	Cables & Cable Supporting Structures
11.1	Checking of continuity / phasing and IR values for all the cables before and after HV test.
11.2	HV test and measurement of leakage current after termination of cable kits (for HT cables)
11.3	Checking of earth continuity for armour.
11.4	Check for mechanical protection of cables.
11.5	Check for identification (tag number system) distance placement of cable marker, cable joint etc. as per the cable layout drawing.
11.6	Check earthing of cable structures.
11.7	Check safe head room in gallery area.
11.8	Check clearance from ventilation duct and light fittings for cable structures.
11.9	Check proper fixing of cable structures.
11.10	Check for proper drainage and removal of water (if any). Checking proper dressing of all the cable laying as cable routing and layout drawing before charging.
12	Indoor Lighting
12.1	Check dressing of cable.
12.2	Measurement of lux level at various places.
12.3	Check accessibility for replacement of lamps.
12.4	Checking for black spots or poor visibility near operating and indicating equipments.
12.5	Check for mechanical protection of cables.
12.6	Checking for adequacy of emergency DC light.
12.7	Checking for starting system of periphery lighting.
12.8	Check for auto switching of battery supply on failure of AC.
12.9	Checking of earthing of light panel, socket boards light fittings.
12.10	Checking of type of fittings w.r.t. specification at various locations.
12.11	Check adequacy of support of fittings.
12.12	Check water tightness of outdoor located panels.
13	Outdoor Lighting System
13.1	Check lux level of general lighting.



13.2	Check for visibility of insulators, bushings and indicating instruments of transformers, breaker and isolator cabinets etc. during night.
13.3	Check for adequacy of escape light during night after failure of general light.
13.4	Check for proper painting of lighting supporting structures.
13.5	Check for automatic switching of light
13.6	Check for earthing connections on light fittings and other control accessories.
13.7	Check for mechanical protection of cables.
13.8	IR measurement of lighting cables.
14	Earthing
14.1	Check tightness of all earth connections.
14.2	Check two point separate earthing of all metallic equipments, cable trays, busbar supporting structures, yard fencing steel structures of yard, rails gates building column (if steel all elect equipments, gas / oil / water pipe lines etc. as per the drawing / specification
14.3	Measurement of earth resistance for each electrode.
14.4	Measurement of total earth resistance.
14.5	Measurement of earth loop resistance for E/F path of biggest LT drive. Measurement of treated earth pit resistance. Checking of proper connection and identification of each treated earth pit.
15	Lightning Protection
15.1	Check continuity of all the earth strips / shield wire.
15.2	Check tightness of all connections.
15.3	Measure earth resistance of each electrode and combined system.
16	Ventilation system
16.1	Check tightness of all foundation bolts, coupling bolts
16.2	Check for cable dressing
16.3	Check level of fan
16.4	Check for lubrication of bearing and tightness of bearing
16.5	Check for belt alignment
16.6	Checking of all duct support
16.7	Checking for close / open operation of all dampers
16.8	Check for key in motor and fan pulley
16.9	Check no foreign material inside fan casing
16.10	Check freeness of fan and impeller by hand rotation
16.11	Check tightness of belt
16.12	Check for safety guard for all rotating drives
16.13	Flexible machinery connection at fan inlet and outlet



16.14	Fan air washing system spray nozzle, supply and return pipe re-circulating pipe line, make upwater pipeline, float valve, water line gate valve, pump operation should be checked for proper functioning
16.15	Dry panel filter to be cleaned at regular interval and check whether the PD is within allowable limit if manometer is provided.
16.16	For viscous oil filter, rotation of filter mat, sludge removal, gear motor functioning to be checked at regular interval. Filter should rotate / move freely.
16.17	Check the completeness of the system and layout wrt approved drawings.
16.18	Check whether vibration is excessive
16.19	Operation (closing / opening) of damper can be done freely
16.20	For electric drives
16.20.1	IR measurement
16.20.2	Measurement of no load current
16.20.3	Calibration and operation of over load relays
16.20.4	Measurement of vibration without and with belt
16.20.5	Measurement of vibration
16.20.6	Checking for earthing connection
16.20.7	Check for all inter lockings
16.20.8	Check temp, rise of body, bearings, etc.
17	Lightning arrestor
17.1	Check for connection to ground
17.2	Check insulators for cracks
17.3	Check reading of leakage current
17.4	IR test of each element Measurement of earth resistance for LA
18	Miscellaneous
18.1	Checking of continuity of the system.
18.2	Checking of phase sequence from overhead line consumer end.
18.3	Checking safe accessibility of all operating points
18.4	Check availability of emergency lighting
18.5	Check availability of control aux. supply.
18.6	Ensure availability of first aid box, fire fighting equipments, earth discharge rods, rubber mats, rubber glove.
18.7	Check oil drainage system for transformer oil
18.8	Check filling of gravels in transformer pits.
18.9	Check working of ventilation system for battery room transformer room



18.10	Check for safe movement of operators from yard control room / switchgear cable gallery etc., wrt proper illumination, escape light uncovered openings provision of hand railings in stairs etc.
18.11	Check proper covering of cable channels.
18.12	Placement of shock treatment chart, danger boards provision of boards indicating 'Man on work' 'Do not switch ON' 'Do not switch OFF'. 'EARTHED' etc.
18.13	Provision of route map at gallery entry points for indication of escape.
18.14	Check proper dressing of cables, mechanical protection of cables, placement of cable markers.
18.15	Check sealing of all cable openings including conduits opening with fire resistance material.
18.16	Check sealing of all openings at bottom of electrical panels.
18.17	Check and testing of all equipment of lab and repair shop as per the manufacturer's commissioning manuals.
18.18	Checking of all control logics and interlocks and trip tests on circuit breakers by simulation.
18.19	Checking of annunciation and indication circuits where applicable.
20.0	For all equipment including, Bidder to refer to OEM's recommendation and furnish the individual Filed Quality Plans for Owner's approval.
21.0	Installation checks as per OEM guidelines to be followed subjected to Owner / Owner's Engineer approval.

NOTE: The Bidder shall note that the Site Acceptance Test (SAT) is a part of the scope of work. The Bidder shall prepare and submit a detailed SAT plan for all major electrical equipment along with the Technical Bid. The SAT plan shall be as per applicable standards, The Sat procedure/plan shall be subject to Owner approval.

Routine site testing list shall be included for LT variable frequency drives including measurement of harmonics at the output of variable frequency drives as well as at the point of respective 6.6kV bus during operation of drives starting from no load to full load.



SECTION-6 TECHNICAL SPECIFICATION FOR CONSTRUCTION POWER SUPPLY

1. Construction power supply (3-Phase) for the proposed project which will be made available to the successful Bidder at one point only on **chargeable basis**. Bidder shall carry out further distribution of power through underground cabling only to meet their construction requirements. Bidder shall procure sufficient number of required panels, DP structure, switch with structure, energy meters, distribution transformer, distribution boards, HT / LT cables etc.

Power supply availability is subjected to availability of power and making alternative majors, like providing DG set, to ensure the continuous availability of power for completion of the work as per the schedules shall be the responsibility of the Bidders.
2. Bidder shall supply and install electrical equipment as per regulations of the local electrical inspectorate / Statutory body for electrical installation. Bidder shall be responsible for liaisoning with government authorities / for getting all the necessary clearances from electrical inspector/DGVCL including all statutory fees. Bidder shall supply and install fire fighting equipment as per the regulations of the local electrical inspectorate / statutory bodies for the temporary electrical installation.
3. On award of contract, the BIDDER shall furnish the electrical scheme, for construction power supply for OWNER's review / approval. The Bidder shall indicate 6 monthly maximum demand requirements.
4. Operation and Maintenance of all construction power supply equipments is in the scope of Bidder. Bidder shall engage round the clock shift manpower for construction power facility.
5. After the completion of the job, the BIDDER shall remove the entire installation and make area available to the OWNER.
6. Sufficient temporary lighting in all areas including road lighting, lighting mast, watch tower, boundary wall lighting shall be provided to facilitate construction activities round the clock. Bidder shall submit detailed drawing with site enabling program for approval of Owner / Engineer.
7. Submersible pumps / dewatering pump (especially in monsoon) shall be arranged and operated by the Contractor.



8. Construction of switchgear building with all necessary equipment, its foundations, DP structure, fencing, treated earth pit, cabling etc. as per statutory requirement is in the Bidder scope.
9. Bidder to arrange DG sets as back-up power supply arrangement during critical continuous. List of such critical continuous activities shall be mutually discussed or finalized during contract stage if required.
10. Bidder has to furnish their start-up and commissioning power requirement month-wise at-least prior to 04 (four) months from the start date of commissioning till COD operation.



SECTION-7 DOCUMENTS WITH BID

ELECTRICAL SYSTEM

The technical parameters as sought for in this section and all other sections along with other schedules shall be filled in and furnished with the Bid.

1. Auxiliary Power Supply System

- a) Bidder shall prepare Key One line Diagram. This shall cover power distribution from 6.6 KV up to 415V.
- b) Bidder shall prepare 6.6 kV Bus diagram.
- c) Auxiliary system write up indicating the standby sources, switchgear, arrangement of redundant auxiliaries, live changeover arrangement, automatic changeover, control mode from control room, etc.
- d) Electrical single line diagram indicating the configuration and rating .
- e) Load list indicating kW rating, load factor, no of running / standby, pf, efficiency etc.

2. 6.6 kV HT Switchgear

- a) Experience list for the make and type of 6.6 kV breakers offered.
- b) Descriptive literature on the circuit breaker and accessories
- c) Type test certificates for the breakers, switchboards.
- d) Performance certificate from other client for similar system/equipments.

3. Service Transformers

- a) Calculations for sizing the transformers MVA rating and the impedance.
- b) Performance certificate from clients, type and routine test certificates for dry cast resin transformer.

4. 415 V LT Switchgear

- a) Performance certificate from other client for similar system/equipments.
- b) Descriptive literature/pamphlets on the switchboards offered and main components like circuit breakers, relays, contactors



- c) Key One Line diagram showing the interconnection of various Switchgear /MCC, ratings of all the bus bars, the incomer breakers and bus couplers/ties.
- d) Type test certificates.

5. Neutral earthing equipment

- a) Performance certificate from other client for similar system/equipments.

6. DC System

- a) Descriptive literature / pamphlets of DC switchboard
- b) Write-up on switchboard construction.
- c) Single-line diagram showing ratings of all the buses, incomers, ties, etc.
- d) Performance certificate from other client for similar system/equipments.

7. HT/LTMOTORS

- a) Details of energy efficient motors offered.
- b) Details of drives offered with Variable Frequency Drive and calculation of payback period for VFD.

8. VFD Drives

Drawings/Documents for the VFD to be furnished by the Bidder

- a) General arrangement drawings showing outline dimensions, cable entry openings, fixing/foundation details, weights and door openings.
- b) Front & cross section views showing arrangement details of equipment and terminals and with Bill of Material for all equipment.
- c) Schematic diagram indicating terminal number for external connections & block diagram of control system.
- d) MANUFACTURER'S technical literature on various equipments supplied.
- e) Wiring diagram of complete inverter. This will be based on approved schematic drawing. The correctness of this drawing will be the responsibility of the VENDOR.
- f) Test certificates for the cabinet and all individual equipments and performance load tests will be submitted atleast 2 weeks before despatch of equipment.
- g) Operation and maintenance manuals will be furnished with the equipment.



- h) Detailed drawing of converter showing layout of power semiconductors, fuses, heat sinks, cooling system etc.
- i) Details of testing procedures for power semiconductors and power converters as per Standards/Code of Practice for approval.



SECTION-8 DOCUMENTS AFTER AWARD OF CONTRACT

1	<u>ELECTRICAL WORKS</u>		
1.1	Concept note covering the equipment main parameters, design and operation philosophies including synchronising through auto synchroniser and manual synchronising gear, sizing criteria, selection criteria, schemes proposed, operation, indication and alarm philosophies for all electrical equipment/systems.		A
1.2	Technical specifications and technical data sheets for all electrical equipment/systems.		A
1.3	Electrical equipment layout drawings in all buildings.		A
1.4	Cable tray/trench layouts, lighting layouts, earthing & lightning protection layouts, fire alarm system layouts, communication system layouts, etc. for all buildings/areas.		A
1.5	Relay settings along with calculation and co-ordination curves/chart.		A
1.6	Standard/typical installation sketches for cabling, lighting, earthing and lightning protection.		I
1.7	Control wiring diagrams for each drive / auxiliary	: Showing the details of the switchgear module, external cable connection to motors, devices, control panels, system cabinets, etc., interconnection between panels related to the respective drives, cable nos., and cable core nos.	A
1.8	Cable interconnection schedules / diagrams for all the cables showing the cable no., core no., cable size, terminal nos., on either side for all the equipment in the Bidder's scope		I
1.9	Bidder shall furnish the following drawings / data / information:		
1.10	<u>Transformers</u>		



	(a)	General outline drawings showing plan, front elevation, end elevation, cable boxes / disconnecting chamber section views, locating dimensions of cable entries, earthing terminals, foundation / floor fixing details, jacking pads and weights	A
	(b)	Bushings : Plan, elevation, terminal details, mounting details, make and type number, current and voltage rating, creepage distances and principal characteristics.	I
	(c)	Marshalling box terminal connections: Wiring diagram, Cooler control circuits, OLTC Control circuits, Cooler control cabinet drawings	I
	(d)	Rating and diagram plates,	A
1.11	<u>Motors (AC and DC)</u>		
	(a)	Dimensioned outline and general arrangement drawing of motor	I
	(b)	Internal view of terminal boxes showing connection of motor i.e., star / delta terminal markings, clearance between phases, disconnecting facilities and direction of cable entry and cable glands.	I
	(c)	Motor characteristics curves	I
1.12	Motor Operated Valve Actuators		
	(a)	Drawing indicating overall dimensions and mounting details of valve actuator on the valve	I
	(b)	Detailed internal wiring diagram of the actuator.	I
1.13	<u>6.6kV Switchboards, 415 V Switchboards DCDB & All other LT Panels (i.e. AVDB, MLDB, LP etc.)</u>		
	(a)	Switchgear cubicles: Outline dimensions and general arrangement, including plan, front elevation, rear elevation, side elevation and relevant cross-sectional views, foundation details	A
	(b)	Feeder List and Schematic control circuit diagrams	A



	(c)	Detailed wiring diagrams including terminal block numbers, ferrule numbers and cable connections.	I
	(d)	Development diagrams of switches	I
	(e)	Switchgear schematic diagrams of all 6.6kv & 415V boards/ switchgears	A
1.14	<u>Electrical Control Panels</u>		
	(a)	Outline dimensions including plan, front elevation including the mimic, rear elevation, side elevation and door opening sizes.	A
	(b)	Drawings showing foundation details, floor openings for cabling and weight of each panel	I
	(c)	Schematic control circuit and block logic diagrams. The latter shall indicate the location of all devices relays, sensors, transducers, instruments and their interaction to serve as a basis for developing elementary diagrams	I
	(d)	Layouts and cross section views of front / rear panels and desks complete with identification markings for all mounted devices and complete material list giving ratings, make and type.	I
	(e)	Switch development diagrams	I
	(f)	One line diagrams of power circuits and control power circuits arrangement and distribution.	I
	(g)	Detailed wiring drawings including identification of devices, terminal block numbers, ferrule numbers and cable connections.	I
	(h)	Inter panel interconnection diagrams indicating terminals and external connections between panel to panel and panel to field devices.	I
	(g)	Control philosophy write up	I
1.15	<u>Control Cabinets (For all services)</u>		



	(a)	Schematic diagram indicating terminal numbers for external connections and with a Bill of Material for all the equipment	I
	(b)	Control cabinet drawing showing outline dimensions, cable entry openings, floor / wall / pedestal fixing arrangement, padlocking arrangement, weights	I
1.16	Variable Frequency Drives		
	(a)	General arrangement dimensioned drawings showing outline dimensions, cable entry openings, fixing foundation details, weights and door arrangements, earthing terminals and weights and door openings.	A
	(b)	Front and cross section views showing arrangement details of equipment and terminals and bill of material for all equipment.	I
	(c)	Schematic diagram indicating terminal numbers for external connection	I
	(d)	Write up on the control philosophy and block diagram of control system	A
	(e)	Manufacturer's technical literature on various equipment supplied	I
	(f)	Wiring diagram of complete inverter	I
1.17	<u>Batteries (220 V DC)</u>		
	(a)	Layout drawing	A
	(b)	Drawing showing constructional details of cell.	I
	(c)	Battery characteristics / curves	I
1.18	<u>Battery Charger (220V)</u>		
	(a)	Detailed schematic diagram of charger scheme including voltage / current regulator electronic controller, undervoltage / overvoltage / overload / earthfault relays, annunciation scheme, etc.	A



	(b)	General arrangement drawing showing main dimensions, type of mounting, location of various devices, etc..	I
1.19	<u>Lighting System</u>		
	(a)	Distribution boards and panels general arrangement dimensioned drawings showing front, side and plan views, outline dimensions, floor openings, floor / wall / structure fixing arrangements, earthing terminals and weights.	I
	(b)	Schematic wiring diagram of the distribution boards / panels, showing the terminal numbers.	I
	(c)	Inside view of distribution boards / panels showing mounting and wiring arrangement of various component equipments.	I
1.20	<u>Fire Proof Sealing for Cable Carrier Systems</u>		
	(a)	Detailed drawings including the constructional features, outline dimensions, general arrangement and cross-sectional views of the Fire Proof Sealing System to be provided in the areas specified in specification for each type of fire stop and fire break supplied.	I
	(b)	Type test certificates as per this specification for all types of fire stop / fire breaks included in the order.	I
1.21	<u>Neutral Grounding Cubicle & Neutral Grounding Resistor</u>		
	(a)	General outline drawing with dimensions and weights	A
	(b)	Detailed outline drawing showing plan, front elevation, end elevation, inner view, locating dimensions of cable entries, terminal details, structure / floor fixing details and weights of the cubicles.	I
	(c)	Schematic diagrams with all the parameters for the cubicles	I
	(d)	Sizing calculation for NGR/NGT	A
2	<u>QUALITY, INSPECTION, SHOP AND SITE TESTING</u>		



2.1	Quality assurance plan for all the systems/equipment/ components	A
2.2	Quality assurance plan for all site activities including erection, pre-commissioning, testing and commissioning for the entire plant Package	A
2.3	Preliminary and final shop test schedule for all the systems/equipment/ components	I
2.4	Detailed shop tests procedures including sample calculations for all the systems/equipment/ components	I
2.5	Detailed site tests procedures including sample calculations for all the systems/equipment/ components	I
2.6	Material test certificates and performance test certificates for all equipment tested at works	I
2.7	Procedure for tests before taking-over which shall include performance guarantee tests, unit characteristic test, reliability test etc.	A
2.8	Inspection test reports including test certificates as called for in quality assurance plan for all the systems/equipment/ components.	I
2.9	Type test, Acceptance tests and Routine test reports of all equipments/systems	A
3	<u>ERECTION AND COMMISSIONING MANUALS</u>	
3.1	Storage instructions for all equipment	I
3.2	Erection and commissioning manuals for all the systems/equipment/components including installation drawings	I
4	<u>OPERATION AND MAINTENANCE MANUALS</u>	I
	Operation and Maintenance manuals for all the systems/equipment/ components of the plant package	
5	<u>AS BUILT DRAWINGS / DOCUMENTATION</u>	
5.1	As-built drawings and documentation for the entire plant package, all equipment / system supplied under this contract, for all building / structures / works under this contract incorporating all changes / modifications upto the time of commissioning / handing over to the PURCHASER.	I



5.2	Project design manual consisting of concept studies of all the systems, design criteria, sizing calculations for all major equipment / systems bill of material, equipment list etc.	I
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SECTION-9 CODES & STANDARDS

1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
Standards indicated in the specific sections also to be referred. In the event of conflict between the codes and standards referred below and the specification included in tender documents, the stringent requirement will be considered.					
A.	TRANSFORMERS				
1	Power Transformer	2026	171	176	
2	Fittings and accessories for Power Transformer	3639			
3	Distribution transformer	1180			
4	Loading of oil immersed transformer	6600	CP:1010	354	
5	Oil	335	148	296	
6	Bushing for > 1000V, AC	2099	223	137	
7	Bushing for ≤ 1000V, AC	7421			
8	Dry type transformers				C-75.12.01
9	Buchholz relay	3637			
10	Pulse transformer	6297	2214		
11	Reactor	5553	60289	60289	
12	Neutral earthing transformer	3151	171 / BSEN 60076	60076	
B.	SWITCHGEARS				
1.	LV Switchgear and control panel	13947	7354		
2.	Degree of protection for LV Switchgear	2147		144 / 947	
3.	Factory built assemblies of low voltage switchgear and control gear	13947		439	



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
4.	Specification for metal clad base materials for printed circuits for use in electronic and telecommunication equipment	5921			
5.	Electrical insulation classified by thermal stability	1271	2757	85	
6.	Metal enclosed switchgear	3427	162	298	
7.	Switchgear			62271-100 & IEC-62271-200	
7.	HT Circuit breakers	13118	116 / 3659 / 5311	62271	
8.	Switches and switch isolators above 1000V and upto 11 kV			265	
9.	(Off-Load) isolators, EHV Isolators	1888	3078 / 3189	129 / 156	
10.	Arrangement for switchgear busbars, main connection and auxiliary wiring	5578 / 11353	158		
11.	Bus bars	5082	159	105	
12.	Bus bar support insulators	2544	3297	273	
13.	Current transformers	2705	3938	185	
14.	Potential transformers	3156	3491	186	
15.	AC Electricity meters	722	2692 5685		
16.	Electrical indicating instruments	1248	89	51	
17.	Electrical relays for power system protection	3231	142	255	
18.	High voltage fuses	9385			
19.	HRC Fuses	9224			
20.	SF-6 Gas			376	
21.	H.V. Cable Termination			18	



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
22.	Environmental requirements of semiconductor devices and integrated circuits	6553			
23.	Factory built assemblies of switchgear and control gear for voltages upto and including 1000V AC and 1200V DC	8623	60947	439	
24.	Miniature circuit breakers	8828	3871		
25.	HRC cartridge fuse	13703	88		
26.	D-Type fuses	8187			
27.	Control switches / push buttons	6875			
28.	Static protection relays	8686	142		
29.	Electric graphic (Recording) instruments		90		
30.	Starters	13947	EN-60947-4	292	
31.	Interconnecting bus bars for AC voltage above 1 kV upto and including 36 kV	8084			
32.	Code of practice for selection, installation and maintenance of switchgear and control gear.	10118			
33.	Semiconductor converters			146	
34.	Semiconductor rectifier cells and stacks	3895 / 4540	4417	146	
35.	Electrical installation and wiring installation	732			
36.	Environmental testing procedure for electronic and electrical items	9000			
37.	Safety code for semiconductors rectifier equipment	6619			
38.	Printed wiring boards	7405			
39.	Single and double sided PCB with plain holes – Electromagnetic compatibility			61000 – 1995	
40.	Semiconductor rectifier assemblies and thyristor convertors		4417	148	



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
C.	ROTATING MACHINES				
1.	Three phase induction motors, generators	325	4999	34	
2.	Rotating electrical machines	4722			
3.	Single phase small AC and universal electric motors	996			
4.	Three phase induction motors with type of protection 'n'	9628			
5.	Construction and testing of electrical apparatus with type of protection 'e'	6381			
6.	Designations for types of construction and mounting arrangement of rotating electrical machines	2253		34-7	
7.	Terminal marking and direction of rotation for rotating electrical machinery	4728	4999	34-8	
8.	Designation of methods of cooling for rotation electrical machines	6362	4999	34-6	
9.	Measurement and evaluation of vibration of rotating electrical machines		4999-142	34-9	
10.	Degrees of protection provided by enclosure for rotating electrical machinery	4691	4999	34-5	
11.	Guide for testing three phase induction motors	4029		34-34	
12.	Measurement and evaluation of Mechanical vibration of rotating electrical machines	12075	4999	34-14	
13.	Classification of hazardous areas	5572		79	
14.	Dimensions of slide rails for electric motors	2968	4999		
15.	Permissible limits of noise level for rotating electrical machines	12065		34	
16.	Guide for testing insulation resistance of rotating machines	7816			



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
17.	Procedure for measurement of loss of tangent angle for coils & bars	13508			
18.	Impulse voltage withstand test			34-15	
19.	Temperature rise measurement of rotating electrical machines	12802			
20	Type of duty and classes of rating assigned to rotating electrical machines	12824			
D.	VFD				
1.	Standard for Power Conversion Equipment				UL 508C
2.	Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable speed drives				ICS 3.1
3.	Semiconductor converters				60146
4.	EMC Requirements				IEEE/ EN 61800
5.	Electronic equipment for use in power installations				EN 50178
E.	ELECTRICAL INSTALLATION				
1.	Brass glands for PVC cables	12943			
2.	Flame-proof enclosures of electrical apparatus	2148	4683		
3.	Compression type tubular terminal ends for aluminium conductors of insulated cables	8309	4683		
4.	Code of practice for earthing	3043	1013		



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
5.	Rigid conduits	9537			
6.	Accessories for rigid steel conduits for electrical wiring	3837			
7.	Fittings for rigid steel conduits for electrical wiring	2667			
8.	Fittings for rigid non-metallic conduits	3419			
9.	Flexible steel conduits for electrical wiring	3480			
10.	Flexible non-metallic conduits for electrical installation	6946			
11.	Adaptors for flexible steel conduits	4649			
12.	Plugs and socket outlets	1293			
13.	Lightning arrester	3070	BSEN-60099	60099	
14	Insulating Mats for Panels	15652			
F.	LIGHTING				
1.	General and Safety Requirements for luminaires	1913	4533	60598	
2.	Code of practice for industrial lighting	6665			
3.	Industrial luminaire with metal reflectors	1777		60598	
4.	Decorative lighting outfits	5077			
5.	Dust proof electric lighting fittings	4012		60598	
6.	Dust tight electric lighting fittings	4013			
7.	Electric lighting fittings for division 2 areas	8224	4533		
8.	LED Luminaires	10322			
9.	Water proof electric lighting fittings	3528	4533 / 5225		
10.	Watertight electric lighting fittings	3553	4533 / 5225		
11.	Bayonet Lamp Holders	1258	BSCN: 61184	60061	



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
12.	Edison Screw Lamp Holders	10276	BSCN: 60238		
13.	Bi-pin Lamp Holders for Tubular fluorescent lamps	3323			
14.	Starters for fluorescent lamp	2215	BSCN: 60155		
15.	Holders for starters for tubular fluorescent lamps	3324	BSCN: 60400		
16.	Ballast for Fluorescent lamps	1534	BSCN: 60920	60400	
17.	Transistorised ballasts for fluorescent lamps	7027			
18.	Ballasts for HP Mercury Vapour Lamps	6616		60923	
19.	Capacitors for use in tubular fluorescent, HPMV & LP Sodium Vapour Discharge Lamp Circuits	1569	BSCN: 61048		
20.	Vitreous enamel reflector for use with illuminating device.	8017			
21.	Tubular Fluorescent lamps for general lighting service	2418	BSCN: 60081	60081	
22.	High pressure mercury vapour lamps	9900	3677	60188	
23.	Tungsten filament general service electric lamps	418	6179	60432	
24.	Cast acrylic sheets for use in luminaires	7569			
25.	High pressure sodium vapour lamps	9974			
26.	Emergency lighting units	9583			
27.	Code of practice for interior illumination	3646	8206		
28.	LED lamps	16102			
G.	FIRE PROTECTION				



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
1.	Code of practice for fire safety of industrial buildings : Electrical Generating and Distributing Stations	3034			
2.	Components of automatic fire detection system : Introduction		5445		
3.	Specification for manual call points		5839		ANSI UL38
4.	Smoke detectors for use in automatic fire alarm system	11360	5445		UL 268
5.	Smoke detectors for duct application				UL268A
6.	Single & multiple station smoke detectors				UL 217
7.	Heat sensitive fire detectors for use in automatic fire alarm system	2175	5445		
8.	Specification for high temperature heat detectors		5445		
9.	Methods of test of sensitivity to fire		5445		
10.	Auxiliary protective signalling system for fire alarm services				ANSI – NFPA – 72
11.	Automatic fire alarm system in buildings : Control & indicating equipment		3116		
12.	Protection of buildings and allied structures against lightning	2309	6651		
13.	Code of practice for fire safety of buildings	1646			
14.	National Electric Code				Article 760
15.	National Building Code of India (1983)				
16.	Rules for fire alarm system				TAC
H.	DC SYSTEM				



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
1.	Stationary cells and batteries				
	Lead acid type				
	- With tubular positive plate	1651		60896	
	- With plants and positive plate	1652	6290-2	60896	
2.	Quality tolerances for water for storage battery	1069	4974		
3.	Sulphuric acid	266	3031		
4.	Rubber and plastic containers for lead acid storage battery	1146			
5.	Sealing compound for lead acid batteries	3116			
6.	Synthetic separators for lead acid batteries	6071			
7.	General requirements and methods of test for lead acid storage batteries	8320			
8.	Recommended practice for sizing large lead acid storage batteries for generating stations and sub-stations				IEEE 485
9.	Containers and Vent Plugs				UL 924
10.	Battery enclosures				UL 1778
11.	IEEE recommended practice for sizing Ni-Cd batteries for stationary applications				IEEE 115
I.	GENERAL				
1.	Climate proofing		CP:1014		
2.	Code of practice for phosphate coatings of iron and Steel	6005	3189		
3.	Classification of maximum surface temperature of electrical equipment for explosive atmospheres	8239			
4.	Method of marking for identifying electrical equipment for explosive atmospheres	8241			



1	APPLICABLE STANDARDS	IS	BS	IEC	ANSI / IEEE
5.	Flame proof cable glands	4821			
6.	Ambient temperature of electrical equipment	9676			
7.	Terminals for electronic equipment	4007			
8.	Guide for colour coding of electrical mimic diagrams	11954			
9.	Boxes for enclosure of electrical accessories	5133			
10.	Codes for welding	816, 9595			
11.	Dust-tight Ignition proof enclosures, for electrical equipment	11005			
12.	Electromagnetic compatibility			6000 – 1995	
13.	Code of practice for climate proofing		6751		
14	Code of practice for selection, Installation and maintenance of transformers	10028			
15	Code of practice for maintenance and supervision of mineral insulating oil in equipment	1866	5730	422	
16	Code of practice for Installation and maintenance of induction motors	900			
17	Guide for safety procedures and practices in Electrical work Indian Electricity Act	5216			
18	Indian Electricity Act 1910, (As amended)				
19	Electricity Supply Act, 1948, (As amended)				
20	Indian Electricity Rules, 1956 (As amended)				
21	Indian Electricity Act 2003				

CEA GUIDELINES/ REGULATIONS

SL. NO	CEA GUIDELINES/ REGULATIONS	YEAR
01	Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines	2022
02	Installation and Operation of Meters	2022
03	Technical Standards for Connectivity to the Grid	2019
04	Technical Standards for Construction of Electrical Plants and Electric Lines	2022
05	Technical Standards for Communication System in Power System Operations	2020
06	Flexible Operation of Coal-Based Thermal Power Generating Units	2023

SECTION-10 SCHEDULE OF SUB VENDORS

The vendor list provided by the OWNER is based on experience and for the standardisation purpose. However, OWNER may reject the Contractor's choice even as per the given vendor list, but are not meeting the specific requirements as per the OWNER's specification.

The list of acceptable Vendors/makes for system/equipment are as listed.

ELECTRICAL WORKS

SL.NO	ITEM DESCRIPTION	SUB VENDOR
1	415 V SWITCHGEAR - (PCC/ MCC)	SIEMENS LTD INDIA / SCHNEIDER / L&T
2	6.6 KV SWITCHGEAR	JYOTI / SIEMENS / ABB
3	AC HT MOTOR	BHEL / SIEMENS / ABB
4	AC POWER CONTACTOR	SIEMENS / SCHNEIDER / L&T
5	ACB	SIEMENS / SCHNEIDER / L&T
6	AMMETER VOLTMETER/ WATTMETER	TOSHNIWAL/IMP/AE/MECO/RISHA B
7	AUXILIARY RELAY	SEIMENS / AREVA
8	AVIATION OBSTRUCTION LUMINAIRE	GEC/PHILIPS /WIPRO/VINAY
9	AUX.CONTACTOR	SIEMENS / SCHNEIDER / L&T
10	AUX. OIL FILLED TRANSFORMER	ALSTOM LTD. COLTAMP TRANSFORMERS LTD. / EMCO LTD.
11	AUX. CONTROL PANEL/ LT SWITCH BOARD (DRAW OUT TYPE)	SIEMENS INDIA LIMITED / SCHNEIDER / L&T
12	BATTERY CHARGER	SERVILINK Engineers / HBL NIFE POWER SYSTEMS LTD.
13	220V BATTERY (PLANTE / HDP TYPE)	EXIDE
14	BIMETALLIC OVERLOAD RELAY / AUX. RELAY	SIEMENS / SCHNEIDER / L&T

15	CABLE TRAY	INDIANA ENGG. / INDUSTRIAL PERFORATIONS / PATNI CABLE TRAYS / SADHNA / STEELITE ENGG. LTD. MUMBAI
16	CABLE GLANDS	COMET
17	CABLE LUGS	DOWELL
18	CEILING FANS	KHAITAN/ORIENT/USHA/ BAJAJ / CROMPTON
19	CONTROL CONTACTOR	SIEMENS / SCHNEIDER / L&T
20	CONTROL PANEL & SYNCH. PANEL	SIEMENS / L&T CONTROLS / ALSTOM / SCHNEIDER
21	CONTROL SWITCH	L&T/SIEMENS/ALSTOM/KAYCEE/S ALZER/ BCH
22	CONTROL TRANSFORMER	INDCOIL/AE/BCH/KAPPA/PRECISE / SOUTHERN ELECTRICALS / SILKAANS
23	CT	KALPA/ AE/BHEL/CGL/SILKAANS/JYOTI/KAPPA/ ABB/TELK/WSI/PRECISE/INDCOIL/ PRAGATHI
24	CT / PT	AE/BHEL/CGL/SILKAANS/JYOTI/KAPPA/ ABB/TELK/WSI/PRECISE/INDCOIL/ PRAGATHI
25	EXHAUST FAN	GEC ALSTOM/CROMPTON GREAVES/POLAR/ KHAITAN/BAJAJ/FLAKT/USHA
26	FUSE	SIEMENS
27	FUSE SWITCH UNIT	SIEMENS / L&T
28	HRC FUSE	SIEMENS
29	HT CABLE TERMINATION KIT	RAYCHEM / NEXANS
30	HT/XLPE/FRLS/POWER CABLES	POLYCAB WIRES PVT.LTD UNIVERSAL CABLES TORRENT CABLES
31	INDICATING LAMP	ALSTOM/TM/SIEMENS/L&T/TEKNIC/ PRECIFINE
32	KWHR. METER	BHEL/SIMCO/ABB/ENERCON/L&T/ SEMS



32	LIGHT FITTING (FLAME PROOF)	GE / BAJAJ / CROMPTON / PHILIPS / WIPRO
33	LIGHTING SYSTEM	BAJAJ ELECTRICALS LTD. CROMPTON GREAVES LTD. PHILIPS INDIA LTD. WIPRO
34	LT MOTORS	SIEMENS / ALSTOM LIMITED / CROMPTON GREAVES LIMITED
35	LIMIT SWITCH	SIEMENS/ESSEN/BCH
36	LT TRANSFORMER (OIL TYPE)	VOLTAMP / AREVA / EMCO
37	LT XLPE FRLS POWER CABLES	POLYCAB WIRES PVT.LTD UNIVERSAL CABLES TORRENT CABLES
38	MCB (MINIATURE CIRCUIT BREAKER)	SIEMENS / INDO ASIAN/ SCHNEIDED / L&T
39	MCCB	SIEMENS / SCHNEIDER / L&T
40	MOTOR CIRCUIT BREAKER	SIEMENS / SCHNEIDER / L&T
41	NGR	BCH/S.R.NARKHADE/AMPCCONT ROL
42	NICKEL-CADMIUM BATTERIES	M/S EXIDE
43	PANEL METER	AEL / MECO
44	PIANO SWITCH	ANCHOR / ELLORA / MK ELECTRIC / ALSTOM
45	PUSH BUTTONS	ALSTOM / SIEMENS / L&T /TEKNIC / HONEYWELL
46	PVC FRLS LT POWER &CONTROL CABLES	POLYCAB WIRES PVT.LTD UNIVERSAL CABLES LTD. TORRENT CABLES
47	NUMERICAL RELAYS	SIEMENS / SCHNEIDER
48	SEMICONDUCTOR FUSE	BUSSMAN / FERAZ
49	SHUNT	AEL / MECO
50	SURGE ARRESTOR	ALSTOM / ELPRO/OBLUM/ABB/CGL/SIEMEN S
51	SWITCH SOCKET OUTLET	ALSTOM / CG L/ ANCHOR

52	1-PH & 3-PH RECEPTACLES	BALS / BALIGA
53	TERMINAL BLOCKS (CAGE CLAMP TYPE)	ELMEX
54	TIMER/TIME DELAY RELAY	SIEMENS/L&T/MINILEC
55	VACUUM CIRCUIT BREAKER & VACUUM CONTACTOR	JYOTI / SIEMENS / ABB
56	LT VFD	AMTECH ELECTRONICS (INDIA) LTD / DANFOSS / HITACHI
57	MOTOR BEARING	SKF / FAG
58	EARTH RESISTANCE TESTER	SONEL, SWITZERLAND/FLUKE / MEGGER
59	TRANSDUCERS	SECURE PT1 (PROGRAMMABLE)
60	ENERGY METERS	SECURE ELITE 440
61	HOOTER / SIREN	KHERAJ

NOTE: The name of other reputed vendors who meets the requirement of technical specification may also be included on BIDDER's request, subject to OWNER/ENGINEER approval.