

# BHARAT HEAVY ELECTRICALS LIMITED

## TRANSMISSION PROJECTS ENGINEERING MANAGEMENT



|   |  |          |    |       |          |          |          |
|---|--|----------|----|-------|----------|----------|----------|
| DOCUMENT No.                                      | <b>TB-PBT-316-PN1</b>  | Rev. No. | 00 |       | Prepared | Checked  | Approved |
| TYPE OF DOC.                                      | TECHNICAL SPECIFICATION  |          |    | NAME  | VYOM     | JK       | SKS/AG   |
| TITLE<br><b>220kV KV GAS INSULATED SWITCHGEAR</b> |  |          |    | SIGN  |          |          |          |
|   |  |          |    | DATE  | 05.02.22 | 05.02.22 | 05.02.22 |
|   |  |          |    | GROUP | TBEM     | W.O. No  |          |
| CUSTOMER  | Indian Oil Corporation Limited (IOCL).   |          |    |       |          |          |          |
| PROJECT/<br>TENDER                                | Pre Bid Tie up for 220 kV GIS Package for Panipat Refinery Expansion Project (P25): 220kV GIS with LCC & its Accessories<br>LSTK job for ISBL work of 220KV Grid Power Import at IOCL Panipat Refinery |          |    |       |          |          |          |

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| Rev No.      | Date | Altered | Checked | Approved | REVISION DETAILS |             |
| Distribution |      |         |         | To       | TBMM             | OFFICE COPY |
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# Bharat Heavy Electricals Limited

Project: Pre Bid Tie up for 220 kV GIS Package for Panipat Refinery Expansion Project (P25)

Technical Specification: 220kV GIS with LCC & its Accessories

Doc No. TB-PBT-316-PN1, Rev 00

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**SECTION 1:**

**SCOPE, PROJECT SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES**

## **1. Scope**

This technical specification covers the requirements of design, engineering, fabrication, manufacturing, shop assembly, inspection and testing at manufacturer's works before supply, proper packing and delivery to project site, supervision of unloading & storage at site, and supervision of installation/ erection, site testing & commissioning, putting into successful operation complete with all materials, support structures, anchoring bolts, accessories, commissioning spares & maintenance spares, special spanners, tools & tackles, any specific required ancillary services, SF6 gas for first filling & spare etc. including training of Customer/ BHEL personnel for 220kV GIS with LCC & its Accessories complete in all respects for efficient & trouble-free operation mentioned under this specification.

Hence, the electrical scope of work under this requisition shall include but not be limited to basic and detailed engineering, as required, manufacturing, supply, transportation to site, inspection at manufacturer's work, supervision of installation, commissioning including site testing along with necessary equipment, training to Customer/ BHEL personnel, Insulation coordination studies, supply of all mandatory spares, commissioning spares, special tools and tackles as defined in the equipment datasheet, drawings, standard specifications, standards etc. attached or referred with technical specification.

This section covers the specific technical requirements of 220kV GIS with LCC & its Accessories. This constitutes minimum technical parameters for the above item as specified by the BHEL/ Customer. The offered 220kV GIS with LCC & its Accessories shall also comply with the Section-3 (Project Details and General technical requirements for all equipment under the Project) of this specification.

The specification comprises of following sections:

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

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

### **1. Statutory Regulations**

In particular, the latest version of the following statutory regulations, as applicable, shall

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be followed for system,

- o Indian Electricity Act
- o CEA regulations
- o The Factory Act
- o The Petroleum Rules
- o OISD standards
- o Requirements of other statutory bodies as applicable, e.g. CEA, CCE, LPCB.

2. Section-1

3. Section-2

4. Section-3

5. Codes & Standards

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

The 220kV GIS being supplied shall be with double bus bar arrangement. Due integration of existing 220KV GIS, outdoor 220 KV facilities, transformer system shall be in the bidder's scope. The scope includes supply of a minimum of following items also,

In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer (Annexure-B), however bidder shall furnish list of conflicts/ ambiguities/ deviations (Annexure-A), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

**Any clarification(s) for 220kV GIS published by M/s IOCL with reference to Tender No. SG/B269-999-EB-T-0020/22, Pre Bid Tie up for 220 kV GIS Package for Panipat Refinery Expansion Project (P25) of M/s Indian Oil Corporation Limited (IOCL) will also valid for this specification.**

The equipment is required for the following project:

|                         |  |
|-------------------------|--|
| Name of the Customer    | : Indian Oil Corporation Limited (IOCL)  |
| Name of Consultant      | : Engineers India Limited  |
| Name of Main Contractor | : Bharat Heavy Electricals Limited   |
| Name of the Project     | : LSTK job for ISBL work of 220KV Grid Power Import at IOCL,<br>Panipat Refinery |

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

## 2. Codes & Standards

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The performance, testing and rating of the switchgear shall conform to the latest edition of the following IEC / IS publications,

|                |   |
|----------------|---|
| IEC 60694      | Common clauses for High Voltage Switchgear & Control Gear   |
| IEC 62271-203  | Gas Insulated metal-enclosed Switchgear for rated voltages above 52kV   |
| IEC 62271-207  | Seismic Qualification for Gas-insulated Switchgear Assemblies for rated voltages above 52kV                                 |
| IEC 60376      | New Sulphur Hexafluoride  |
| IEC 62271-100  | High Voltage Alternating Current Circuit Breakers   |
| IEC 62271-1    | Common Clauses for High Voltage Switchgear and Control-Gear Standards   |
| IEC 62271-102  | Alternating Current Disconnections (Isolators) and Earthing Switches  |
| IEC 60044-1    | Current Transformers  |
| IEC 60044-2    | Voltage Transformers  |
| IEC 60137      | Bushings for Alternating Voltages above 1000V   |
| IEC 62271-209  | Cable Connections for Gas-insulated Switchgear  |
| IEC 60480      | Guide to Checking of Sulphur Hexafluoride taken from Electrical Equipment   |
| IEC 60099-1/4  | Non-linear Resistor type Arresters for AC Systems   |
| IEC 60439      | Factory-built Assemblies of Low-voltage Switchgear and Control Gear.  |
| IEEE 80 (2000) | IEEE Guide for Safety in AC Substation Grounding.   |
| CIGRE-44       | Earthing of GIS- An Application Guide. (Electra no. 151, Dec'93).   |
| IEC 61639      | Direct connection between Power Transformers and Gas-insulated metal-enclosed Switchgear for Rated Voltage 72.5kV and above |

These are only indicative list and hence any other codes & standards, if applicable shall be complied by bidder.

## 3. Specific Technical Requirements

---

Specific technical requirements 220kV GIS with LCC & its Accessories shall be as follows,

**220 kV Indoor Double Bus Gas Insulated Switchgear**, 2000 A, 50 kA (3 Sec.), SF6 Breaker with 3 Position & 2 Position Disconnecter for Bus Side, 3 Position Disconnecter for Line Side, High Speed Make Proof Earthing Switch, Capacitive Voltage Detector, Gas Insulated Current Transformer, LCC and SF6 Gas Analyser, Online Partial Discharge Monitoring System, Online SF6 Gas filling system e.t.c. complete.

**GIS Outdoor Type Isolating breaker panel** 220 kV, 2000 Amps, 50 kA (3 Sec) with Local Control Cubicle, - GIS shall be suitable for taking power from overhead ACSR conductor and outgoing shall

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be through cables. Terminal connector for SF6 to AIR bushing is not in bidder's scope of supply.

**Extension of existing 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear with Local Control Cubicle** - "Extension of transformer feeder bays in existing CG make 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear with Local Control Cubicle, other details shall be shared with successful bidder.

Although the indoor GIS system shall be installed in Air Conditioned GIS/ Switchgear hall, but same shall also be suitable for installation and satisfactory operation in a non-air conditioned, tropical, humid and corrosive environment.

| Sl. No. | Technical Parameters                    | Unit       | Particulars                            |
|---------|---|------------|--|
|         | Type of GIS                             |            | Indoor & Outdoor Type, Double Bus type |
|         | Installation                            |            | Indoor                                 |
|         | <b>Meteorological data</b>              |            |  |
| 1.1     | Maximum ambient temperature             | °C         | 50                                     |
| 1.2     | Minimum ambient temperature             | °C         | -5                                     |
| 1.3     | Average ambient temperature             | °C         | 35                                     |
| 1.4     | Design ambient temperature              | °C         | 45                                     |
| 2       | Average no. of thunder storm days       | Days       | 45                                     |
| 3.1     | Maximum Relative humidity               | %          | 95                                     |
| 3.2     | Maximum Relative humidity               | %          | 26                                     |
| 4       | Average Annual Rain Fall                | mm         | 900                                    |
| 5       | Maximum Wind Pressure                   | Kg/ sqm    | 195                                    |
| 6       | Maximum Altitude above Mean Sea Level   | m          | 1000                                   |
| 7       | Isoceraunic Level                       | Days/ Year | 45                                     |
| 8       | Seismic Level (Horizontal Acceleration) | Zone       | 4                                      |
| 9       | Average no. of rainy day per Year       | Days/ Year | 120                                    |
|         | <b>Switchgear Design Data</b>           |            |  |
| 10      | Service Voltage                         | kV         | 220                                    |
| 11      | Maximum Service Voltage                 | kVp        | 245                                    |
| 12      | Rated Insulation Level                  |            |  |
|         | -at power frequency 1 min               | kV         | 460                                    |
|         | -at lightning impulse (1.2/50 μs wave)  | kV         | 1050                                   |
| 13      | Frequency                               | Hz         | 50                                     |
| 14      | Rated service current (minimum)         |            |  |
|         | - Bus bar                               | A          | 2000                                   |
|         | - Input Feeder bay                      | A          | 2000                                   |
|         | - Transformer bay                       | A          | 1250                                   |
|         | - Bus coupling bay                      | A          | 2000                                   |
| 15      | Rated short time withstand              | kA         | <b>50</b>                              |

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|    |  |          |  |
|----|--|----------|--|
|    | current (Symmetrical)                                  |          |  |
|    | - Duration   | Seconds  | <b>3</b>   |
| 16 | Internal fault withstand time without burn Through     | ms       | As per IEC-62271-203                                     |
| 17 | Temperature rise at rated service current (indicative) |          |  |
|    | - Conductor  | °C       | As per IEC-60694   |
|    | - Enclosure  | °C       |  |
| 18 | Rated SF6 gauge pressure at 20°C                       |          |  |
|    | - Circuit breaker                                      | bar rel. | As per standard  |
|    | - Switchgear   | bar rel. |  |
| 19 | Enclosure design pressure                              |          |  |
|    | - Circuit breaker                                      | bar rel. | As per standard  |
|    | - Switchgear   | bar rel. |  |
| 20 | Leakage rate of SF6 per annum for the whole substation | %        | < 0.5  |
| 21 | Maximum partial discharge level                        | pC       | ≤ 5  |
| 22 | Factory Dielectric routine test 50Hz                   | kV       | 460  |
| 23 | Site dielectric test                                   | kV       | 380  |
| 24 | Painting of switchgear                                 |          |  |
|    | - Coating design and execution                         | RAL      | As per detailed Specification/ Standard.                 |
|    | - Top coat colour                                      | RAL      |  |
| 25 | Surface protection of steel frames                     |          | Hot-dip Galvanizing with Zinc with 610gm/ square meter   |
| 26 | Degree of Protection                                   | IP       | 42   |
| 27 | Disconnecter class                                     |          | M2   |
| 28 | Rated line charging interrupting current of breaker    |          | <b>As per IEC on light loaded line and 4 km of cable</b> |
|    |  |          |  |

Insulation co-ordination studies for the 220 kV GIS substation package to finalize location and quantity of surge arrestors required in addition to those shown in SLD. Insulation co-ordination studies for the 220 kV GIS substation package to finalize location and quantity of surge arrestors required in addition to those shown in SLD, cost of the same shall be inclusive in the bidder's scope.

All current carrying components of the equipment specified shall be capable of continuous operation at the specified rated current without exceeding the maximum temperature rise specified in the relevant IEC standards. Thermal calculations shall be based on the climatic conditions mentioned elsewhere in specification.

## 4. Bill of Quantities

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1. GIS shall be Double Bus configuration complete with local Control Cubical (LCC). Typical Bay includes Busbar, Circuit Breaker, Disconnecter & Maintenance Grounding Switch, Fast Acting Make Proof Grounding Switches, Voltage Transformer, Current Transformer, Surge Arrestor, SF6 to Air Bushings/ Cable Connection Module, GIS bus duct, Gas Monitoring Devices, Online PD Monitoring System, Pressure Switches, PD sensors, Pressure relief device, insulator, expansion joint/ flexible, compensator, online SF6 Gas filling system etc complete in all respect. (Refer attached Single Line Diagram & Feeder Datasheets). GIS shall be complete in all respect such as and not limited to all necessary terminal boxes, inspection windows, SF6 gas filling, interconnecting cabling & wirings, grounding connections, gas monitoring systems and piping, trays, support structures, wall / floor Inserts, **Foundation Bolts, Anchor Bolts**. Hence, the scope shall include supply, erection and mounting of hardware and interconnecting cables between GIS to LCC and between LCC to LCC including Cable Trays, Tags, Glands, ferrules, Lugs etc, however cables beyond LCC panel shall be supplied and laid by BHEL under the supervision and input of the bidder.
2. Please refer 220kV Feeder Detail Datasheet (B269-999-16-50-DS-0034 & B269-999-16-50-DS-0033), Single Line Diagram and other sections of technical specification.
3. Quantities for supply and services for 220kV GIS with LCC & its Accessories shall be as per Annexure\_BOQ. Mandatory spares for applicable items shall be as per BOQ attached with the tender document.
4. **GIS Services:** Site service activities shall be carried out at in stages as per requirement or front availability at site, and hence multiple visits for completion of work are envisaged. Site visit for supervision of unloading & verification of materials for proper storage and up-keeping at site includes following activities but not limited to, (a) Supervision of safe unloading of GIS & its accessories at site. (b) Reconciliation, storage & up keeping of materials, with due instructions/ training to site persons for long storage.
5. Supervision of complete GIS System (as per scope of supply) along with all bay Equipments, indoor & outdoor (excluding Bus duct and SF6 to air bushing covered separate BOQ line item) such as and not limited to GIS extension module, GIS bus extension module, surge arrester, voltage transformer, LCC including structure, cabling, earthing & other associated activities shall be included in the scope.
6. **Training of IOCL's personnel, performance guarantee test run for 72 hours of 220 KV GIS** is in the scope of bidder, cost of the same is deemed inclusive.
7. During tender stage No of bays of 220KV GIS may vary. Number bays of 220KV GIS shall be finalized after receipt of Notification of award (NOA) from IOCL.
8. Total contract value after receipt of NOA from IOCL/ scope finalization may vary up to  $\pm 30\%$  at contract stage.
9. SF6 gas, gas wastage for successful commissioning and testing, structure, Earthing and any other item required for completeness of bay/ module shall be deemed included in the Bay and module.
10. Bidder to submit price break-up of spares as per Annexure\_Sapres FOR GIS during tender stage. It shall not be binding on the BHEL to procure all of these mandatory spares.

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11. Length of GIB is purely indicative and same shall be finalized during detailed engineering stage in line with final approval of drawings from IOCL.
12. Prices for all applicable accessories of GIS shall be included in the equipment prices. All items required for completeness of bay/ module such as SF6 gas, sensors, structure, earthing etc. shall be the part of respective bay/ module price. However, in the case of award of contract, Bidder will submit the price break-up for those items.
13. Any Item Not Applicable/ Not quoted by bidder in bid price schedule and found applicable as per system requirement shall be supplied free of cost by bidder.
14. Any other equipment/material required to complete the specified GIS scope of work are inclusive of bidder's scope of supply.
15. **Gas Insulated Bus Duct:** GIB length of 1-phase busduct outside the GIS BAY MODULE shall be considered for mode of measurement. Bus duct lengths shall be taken from the end of bay equipment (VT, LA etc.) to end equipment (SF6 to air bushing, SF6 to oil bushing/ connection etc.). This including SF6 Gas, structure, Earthing, foundation bolt, PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, compensator, insulators etc. Complete in all respect.
16. Connection between GIS to cable connection module is deemed inclusive in the scope of respective GIS Bay cost of the same shall not be paid separately.
17. In the case where shifting of GIS bays shall be called by BHEL due to change in civil architectural drawing (Refer drawing B26900081410240B, SUBSTATION-100 (MAIN RECEIVING SUBSTATION) or revised requirements by BHEL/IOCL or expansion joint in the building that houses GIS, **BOQ quantity for "Gas Insulated Bus Duct" shall be operated for intermediate addition of spacing** for Main Bus to meet the technical requirement. (a) Between sections of bus bars, bus duct connections, and shall be used to create electrical connectivity considering the thermal expansion, (b) Bidder shall consider the bus bar modules including the bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc complete in all respect. Mode of measurement shall be unit length of 1 phase bus duct length requirement due to such shifting subject to shifting is not attributed to bidder.
18. **Total GIS System has three different installation locations in Panipat Refinery Expansion Project (P25)**
  - a. **Substation – 100 MRSS (MAIN RECEIVING SUBSTATION)**
  - b. **Extension to Existing GIS near Switchyard (2 Bays)**
  - c. **Outdoor Switchyard (2 Bays)**

## 5. Other General Requirements

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Other general requirements 220kV GIS with LCC & its Accessories shall be as follows,

1. Power, Control & Instrumentation / Special cable: All cables within GIS, GIS to LCC, between LCC to LCC shall be in bidder's scope of supply. Bidder to provide detailed "Bill of Quantity" during detailed engineering stage. Cabling & termination schedule for the same shall be provided by successful bidder along with AS BUILT drawing during contract stage. Power Cable TB's (for both AC & DC incomer cables) shall be suitable for termination of two wire of 16 Sqmm Aluminum (for each phase / polarity). The cables between LCC to CRP/ Bus Bar Panel shall be supplied and laid by BHEL under the supervision and input of

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- the bidder.
2. Storage shall be provided by BHEL/ its contractor. However, bidder shall provide their tentative space requirement for covered and/ or open store area during tender stage only. In addition to this, bidder shall submit their standard storage instruction manual specifically specifying the item detailed with details of type of storage.
  3. Bidder shall submit list of consumables with shelf life of less than six months and same shall be dispatched just before the erection and only after specific clearance from BHEL/Customer.
  4. Project Site is located in petrochemical/ process industry, which is highly corrosive & abundance of hydrocarbon area. Hence, GIS should be compatible with above requirements during design, material selection and construction of GIS & its accessories and all equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.
  5. Packing of GIS & its accessories shall be suitable for long term storage without any deterioration in quality and performance (minimum 1 years, if required).
  6. Bidder shall offer their latest type tested compact model to accommodate the specified & allocated space as per attached layout drawing of GIS. Bidder to note that if bidder fails to meet above requirement, its technical offer is liable for non-evaluation.
  7. Bidder shall conduct insulation co-ordination studies in line with IEC:60071 for establishing surge arrester rating, quantity and any other requirement for successful operation of GIS.
  8. Bidder shall check and ensure adequacy of system protection for successful operation of GIS. After checking of system by bidder, GIS shall be installed and if any failure, malfunction of any part occurs after/ during commissioning, same shall be replaced immediately without any extra cost.
  9. The 220kV GIS building shall comprise an EOT (Electric overhead travel) crane. EOT crane for GIS is not envisaged in bidder's scope but bidder shall provide all the calculations basis for sizing of EOT crane during tender stage only.
  10. CT/VT parameters mentioned in CT VT parameter document is indicative only. Bidder has to ensure correctness of CT/VT sizing for GIS during contact stage / detailed Engineering stage.
  11. Any change in bay pitch (distance between bays) as per civil requirement for during detailed engineering stage shall be incorporated by the bidder without any cost and delivery implication to BHEL.
  12. Bidder shall include painting and marking of all buses, individual incomers, all outgoing feeders etc. with details such as tag no., feeder rating, sending end source reference etc. for all switchboards.
  13. The GIS shall be designed in such a way that suitable walkways are provided all around the switchgears so that the operators will be able to have free access to all the operating mechanism.
  14. The GIS Equipment shall be complete with all necessary supports, ladders, galleries, staircases, catwalks, movable platforms or walkways (for accessing the equipment above two meters for maintenance and operation), mechanism cabinets, internal cable raceways etc for each bay and it shall be of modular construction and extendable design. All structures, galleries, staircases and walkways shall conform to the relevant Occupational

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Safety and Health Administration (OSHA).

15. Special tools & tackles for installation and testing kits for testing & commissioning including gas handling plant required for successful installation of GIS shall be in bidder's scope, however, it shall be brought at site on returnable basis only.
16. The general Tools and Tackles shall be provided by BHEL, list of the requirement i.e. general tools-tackle, spanners, gauges, slings and other lifting devices, crane, welding machines, drills, general instruments and appliances necessary for the installation of GIS is to be submit by bidder along the technical bid.
17. Bidder to furnish detailed BOQ for non-returnable special Tools and Tackles, if applicable along with unit prices to be handed over to ultimate customer. The prices for the same shall be considered during evaluation.
18. All the testing kits including HV Test Kit required for successful testing / commissioning of offered GIS are to be arranged by bidder on returnable basis. Cost of the same shall be deemed inclusive in the offer.
19. SF6 Gas handling equipment required during erection, testing & commissioning in bidder' It is the responsibility of the contractor to supply all necessary commissioning spares as required unless/ until the equipment/ systems are handed over to the Purchaser (IOCL). scope.
20. Start-up & Commissioning spares are included in bidder's scope of supply and shall be included in the base price. Adequate stock of start-up & commissioning spares shall be made available at the site such that the start-up and commissioning of the equipment /systems, performance testing and handing over the equipment/ systems to the Purchaser can be carried out without any hindrance or delays.
21. ETC work schedule for all the GIS may vary according to readiness of site. Respective dates for the commencement of erection, testing and commissioning activities of GIS shall be communicated to manufacturers from time to time as per the readiness of site.
22. **Final documentation** shall be submitted in hard copy (Seven prints) and soft (Three CDs/DVDs )
23. For all control cables minimum 1 Pair shall be provided as spare.
24. Bidder to submit following **drawings/ documents at tender stage**:
  - Preliminary GAS SLD for the GIS.
  - Preliminary Layout/ section for the GIS.
  - Tentative building size including Colum placement and GIB exit requirement.
  - EOT Crane Details/ sizing.
  - Heat Load calculation for all the three GIS (Indoor part) for AHU load calculation.
  - AC-DC Load cycle, Continuous and Momentary load.

## 6. Earthing of GIS

Bidder to submit detailed calculations and layout drawings for earthing system during detailed engineering stage based on technical specification, bidder's design philosophy, IS/IEC requirement as applicable. Bidder to provide the bill of quantity of entire items required for the earthing of the GIS. However, supply of 40mm MS ROD, 75X12/50x6mm GI Flat shall be

done by BHEL. Any other earthing material, as per design/BOQ, shall be in bidder's scope of supply only. Erection of earthing will be done by BHEL team under the supervision of bidder/manufacturer, as per manufacturer's design.

## **7. Modular Design & Future extensions**

---

1. The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF6 gas circuit breaker, disconnectors, Maintenance Grounding switches, fast Earthing switches, voltage transformers, Current transformers, bus & elbow sections, Gas Insulated Bus-duct, local control cubicle and all necessary components required for safe & reliable operation and maintenance.
2. The GIS shall be of either single-phase enclosure type or three-phase enclosure type for voltage levels of 220kV.
3. In those design where bus bar is continuous, provision is to be made available for isolation of individual bay without disturbing adjacent bay.
4. The switchgear shall be of the freestanding, self-supporting dead-front design, with all high-voltage equipment installed inside gas-insulated, metallic grounded enclosures, and suitably sub-divided into individual arc and gas proof compartments, preferably for:
  - (1) Bus bars
  - (2) Intermediate compartment
  - (3) Circuit breakers
  - (4) Line dis-connectors
  - (5) Voltage transformers
  - (6) Gas Insulated bus duct section between GIS and,
  - (7) Gas insulated bus section between GIS and oil filled transformer.
  - (8) Current Transformers.
5. The bus enclosure shall be sectionalized in a manner that maintenance work on any bus disconnector (when bus and bus disconnector are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus.
6. Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. In case of any internal arc fault in a busbar, busbar disconnector or circuit breaker, of double bus system, repair works must be possible without shutting down complete substation and at least one busbar and the undisturbed bays must remain in operation.
7. The busbar system shall be sectionalized for each bay and contained in individual SF6 gas tight bus compartments to prevent contamination of the gas of the whole bus bar due to fault in one bay zone and refill lesser quantity of SF6 gas.
8. Where bus Coupler is specified and in case of any internal arc fault in a busbar, busbar disconnector or sectionaliser, repair work must be possible without shutting down the complete substation and at least one half of the substation must remain in operation.
9. Documents indicating sequence of repair work steps and description of necessary restrictions during work shall be submitted with the technical manual during as built drawing submission.
10. Each bay module should be equipped with suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.
11. Material clearance certificate shall be issued after demonstration of the functionality of maintenance equipment.

12. Structure Materials for support of GIS, Bus Ducts, SF6 to oil bushing/ connection and SF6 to air bushing/ connection including Foundation Bolts, Embedded Items, Rails and/ or other items structural items required. All steel structure members shall be hot-dip galvanized after fabrication. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

## **8. Maintenance and Repair of Circuit Breaker**

---

1. The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for routine inspection, maintenance and repair without interfering with the operation of the adjacent feeders.
2. The GIS shall be so designed that any component of the GIS can be removed easily. With minimum flexibility in the layout arrangement it shall be possible to remove the circuit breaker with both busbars remaining in service and it shall be possible to remove the disconnectors of the busbars, with one bus bar remaining in service. For achieving this requirement, adequate number of intermediate compartments, if required, shall be provided to ensure equipment & operating personnel's safety.
3. The bidder shall be required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect. The arrangement shall be such that expansion of the original installation can be accomplished with minimum GIS down time.
4. In case of extension, the interface shall incorporate facilities for installation and testing of extension to limit the part of the existing GIS to be re-tested and to allow for connection to the existing GIS without further dielectric testing.
5. All the elements shall be accessible without removing support structures for routine inspections and possible repairs.

## **9. Interchangeability & Future Extension**

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1. As much as possible, all the parts shall be of standard manufacturer with similar parts and assemblies being interchangeable.
2. The GIS system shall be suitable for future extension on either end by the addition of extra feeders, bus couplers, bus-bars, circuit breakers, dis-connectors, and other switch gear components. The arrangement of gas sections or compartments shall be such as to facilitate future extension without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays
3. The layout shall ensure that GIS bus link section is provided for future extension of the GIS buses to avoid de-gassing and modification of the existing bus.
4. The physical layout shall ensure free movement of the SF6 Gas Cart and easy access to all components of the GIS for maintenance purposes.

## **10. Drawings / Documents for Manufacturing Clearance**

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

| Sl. No. | Overall Drawings approval required in Cat I /Cat II  |
|---------|--|
| 1       | 220KV GIS- Gas Schematics with Single Line Diagram (Including CT VT Parameters)  |
| 2       | 220KV GIS- Guaranteed Technical Particulars (Including all GIS equipment)  |
| 3       | 220KV GIS- Layout Plan & Section   |
| 4       | 220KV GIS- Interfacing Drawings for Cable Connection Module, SF6 to Air Bushing, SF6 to Oil Module with Guaranteed Technical Particulars     |
| 5       | 220KV GIS- Equipment Layout with Earthing philosophy   |
| 6       | 220KV GIS- Type Test Reports (Including all GIS equipment)   |
| 7       | 220KV GIS- Secondary Engineering Base Design   |
| 8       | 220KV GIS- Control Schematics for GIS and Local Control Cabinet  |
| 9       | 220KV GIS- Maintenance Equipment Catalogue with Guaranteed Technical Particulars   |
| 10      | 220KV GIS- Quality Assurance Plan & Inspection Test Schedule   |
| 11      | 220KV GIS- Civil Design Specification with Foundation Loading Diagram (Including interfacing details)  |
| 12      | 220KV GIS- Quantification for main Items, Spares, Consumables  |
| 13      | 220KV GIS- 3D OGA Drawing (3D-Model with complete editable data base) compatible with Autocad & Primtech for complete GIS & its accessories. |
| 14      | Other documents as per Technical Specification / BOQ shall be finalized during detailed engineering stage.                                   |

The Manufacturing clearance shall be provided Lot wise, however lot item can be clubbed together subject to approval of drawing/ documents. MFC date will be counted from the date of approval of drawings in Cat I/ cat II , for each lot. **Break-up for lot items shall be done during detailed engineering stage, on receipt of firm order by customer.**

## **11. Type Testing**

The offered 220kV GIS equipment and components shall conform to the type tests as per IEC 62271-203. bidder to ensure at the time of order placement that copies of valid type test certificates for tests conducted on identical design of offered equipment is available. In case of non-availability of type test certificates, same shall be conducted without any cost and time implication to Owner/ EIL

**Please refer document 6-81-1066 Rev. 0, Inspection and Test Plan for EHV GIS Switchboard for details of type test requirement.**

In case any of Type tests have not been conducted on the offered design or there has been a change in the design after the type tests. The requisite tests shall be conducted by bidder on the offered design without any extra cost and delivery impact to BHEL/ Customer.

## **12. Quality Plan**

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The successful bidder shall submit Quality Assurance Plan for major components such as breakers, disconnecting switches, lightning arrestors, earth switches, etc. with in-process inspection methods, tests, records, etc. for BHEL/ Customer approval. Customer hold points will also be included in the plan, which shall be mutually agreed by the BHEL/ Customer and Bidder and approved. In case bidder has reference Quality Assurance Plan agreed with BHEL/Customer, same shall be submitted for specific project to BHEL/ Customer approval. There shall be no commercial implication to BHEL/ Customer on account of Quality Plan approval.

Superior quality control system shall be adopted to assure high product quality. Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of GIS. High reliability of materials shall be ensured so as to keep maintenance work to a minimum. All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all these tests for all the equipment & components shall be deemed to be included in bidder's scope.

## **13. Inspection & Testing**

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1. GIS and its associated materials shall be subject to inspection by BHEL/ Customer or authorized representative at bidder/manufacturers' works. Hence, Bidder shall furnish all necessary information concerning the supply to BHEL/ Customer.
2. During fabrication, the equipment shall be subject to inspection by BHEL/ Customer or by an agency authorized by BHEL/ Customer to assess the progress of work as well as to ascertain that only quality raw material is used.
3. Bidder shall ensure that the hazardous area equipment provided shall have the necessary test certificates and valid CCOE approval certificates.
4. Bidder shall also furnish factory acceptance test (FAT) from manufacturers for BHEL/ customer approval in line with technical specifications.

## **14. Field Testing & Commissioning**

---

1. Bidder shall carry out the supervision of installation, field testing and commissioning of 220kV GIS with LCC & its Accessories. Further appropriate test and commissioning reports and as-built documentation as necessary be submitted.
2. Field testing and commissioning of 220kV GIS with LCC & its Accessories shall be done by Bidder/OEM only.

3. Bidder shall also submit site acceptance testing (SAT) procedures and get them approved from BHEL/ Customer before carrying out the site testing at site.
4. All switchboard protection shall be subject to primary injection test before commissioning.
5. Bidder/ OEM shall coordinate with manufacturers of other equipment wherever required and shall freely and readily supply all technical information for this purpose as and when called for.
6. All electrical equipment shall be said to be installed and mechanically complete after circuit testing, primary and secondary injection testing and loop simulation is complete. Due care and consideration shall be given to the installation of 220kV GIS with LCC & its Accessories.

## **15. Makes of Equipment/ Components**

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Bidder/ vendor while ordering shall ensure the availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply. Bidder/ OEM shall give a notice of at least one year to the BHEL/ Customer before phasing out the products/spares to enable the owner for placement of order for spares and services.

## **16. Packing and Dispatch**

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1. The equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage. Packing of the equipment shall be suitable for long storage (minimum 1 year).
2. The SF6 equipment shall be shipped in the largest factory assembled units within transport and loading limitations and considering handling facilities on site to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner.
3. Each individual piece to be shipped, whether crate, container or large unit, shall be marked special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., and other details as per purchase order.
4. The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains and high ambient temperature.
5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.
6. All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided. Any seals, gaskets, 'O' rings, etc. that will be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Vendor to provide quantity of components accordingly considering permanent installation and commissioning.

## **17. Abbreviations Used**

The following terminology/ acronym hereunder and elsewhere in the technical specification used and their grammatical variations shall unless repugnant to the subject or context thereof, have the following full form hereunder respectively assigned to them, namely,

|        |   |
|--------|---|
| GIS:   | Gas Insulated Switchgear                        |
| LCC:   | Local Control Centre                            |
| IBP:   | Isolating breaker panel                         |
| CT:    | Current Transformer                             |
| DC:    | Direct Current                                  |
| HV:    | High Voltage                                    |
| EHV:   | Extra High Voltage                              |
| kV:    | Kilovolt  |
| Hz:    | Hertz   |
| IP:    | Ingress Protection                              |
| SAT:   | Site Acceptance Testing                         |
| CCOE:  | Chief Controller of Explosives                  |
| OEM:   | Original Equipment Manufacturer                 |
| kV:    | Kilovolt  |
| Hz:    | Hertz   |
| IP:    | Ingress Protection                              |
| PE:    | Poly Ethylene                                   |
| ANSI:  | American National Standards Institute           |
| ASTM:  | American Society for Testing and Materials      |
| BIS:   | Bureau of Indian Standards                      |
| BS:    | British Standard                                |
| IEC:   | International Electro Technical Commission      |
| IEEE:  | Institute of Electrical & Electronics Engineers |
| IS:    | Indian Standards                                |
| NEMA:  | National Electrical Manufactures Association    |
| CEA:   | Central Electricity Authority                   |
| DIN:   | Deutsches Institiut fur Normung                 |
| CCE:   | Continuous and Comprehensive Evaluation         |
| LPCB:  | Loss Prevention Certification Board             |
| CCOE:  | Chief Controller of Explosives                  |
| OEM:   | Original Equipment Manufacturer                 |
| BHEL:  | Bharat Heavy Electricals Limited                |
| OISD:  | Oil Industry Safety Directorate                 |
| IOCL:  | Indian Oil Corporation Limited                  |
| HVPNL: | Haryana Vidyut Prasaran Nigam Limited           |
| ISBL:  | Inside Battery Limit                            |
| OSBL:  | Outside Battery Limit                           |
| LSTK:  | Lump sum Turnkey                                |
| PRPC:  | Petroleum Refining and Petrochemical            |

## Bharat Heavy Electricals Limited

Project: Pre Bid Tie up for 220 kV GIS Package for Panipat Refinery Expansion Project (P25)

Technical Specification: 220kV GIS with LCC & its Accessories

Doc No. TB-PBT-316-PN1, Rev 00

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|      |                                 |
|------|---------------------------------|
| PNC: | Panipat Naphtha Cracker Complex |
| PR:  | Panipat Refinery Complex        |
| GIS: | Gas Insulated Sub-station       |
| URT: | Unit Ratio Transformer          |
| QAP: | Quality Assurance Plan          |
| BOQ: | Bill of Quantities              |
| PR:  | Panipat Refinery                |

## 18. Definitions Used

---

The following expressions hereunder and elsewhere in the technical specification used and their grammatical variations shall unless repugnant to the subject or context thereof, have the following meanings hereunder respectively assigned to them, namely:

1. Battery Limit: The demarcated area within which the Unit is to be located.
2. Bid/Bidding Documents: The totality of the documents comprising the Bidding Document for the notice inviting tender.
3. Contract: The totality of agreement between Customer/ Purchaser/ Owner/IOCL and the Contractor/ LSTK Contractor/ BHEL as derived from the contract documents.
4. Contractor/ LSTK contractor: The bidder selected by the Customer/ Purchaser/ Owner/IOCL for the performance of the work and supply of materials. In this case, it is BHEL.
5. Customer/ Purchaser/ Owner: Indian Oil Corporation Limited.
6. Consultant: Any person(s)/ Firm nominated/ assigned by the Contractor/ LSTK Contractor/ BHEL for providing the engineering consultant services.
7. Bidder/ vendor: The bidder selected for this intended work shall be known as vendor.

## 19. List of Documents/ Drawings

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Following drawing/ documents are attached for information purpose,

1. NTS B269999165000200C, KEY SINGLE LINE DIAGRAM 220KV GIS PACKAGE (SS-100)

In the following documents, bidder to please read as follows

1. EIL / Owner – Please read as BHEL/EIL /IOCL
2. Owner – Please read as BHEL/IOCL
3. Subcontractor – Please read as Bidder
4. Scope of supply & Services mentioned in Section -1 & BOQ shall super shed remaining section of technical specification
5. Please read documents w.r.t. the scope mentioned specifically for GIS, GIS accessories & Other items mentioned in Technical Specifications.

## **20. Exclusions from Bidder's scope (NOT in bidder's scope)**

1. 66 kV GIS system is not in bidder's scope, irrespective of the specification for the same may appear in technical specification.
2. Civil Works i.e. GIS Hall, GIS Foundations civil works
3. Air Conditioning System, Ventilation System, Illumination System, EOT Crane
4. Control Relay & Protection Panels, Numerical Relays, Bus Bar Protection Panel, SAS & ECS system, ACDB, DCDB, Battery, Charger etc
5. 40mm MS Rod, 50X6 & 75X12 GI Flat for earthing
6. Outdoor AIS Equipments
7. 220 kV Cables shall be supplied and laid by others.
8. 220 kV Cable termination kits for GIS shall be supplied by others. Termination of 220 kV Cables at 220 kV GIS end shall be done by others.

## Section-1 Annexure.1

220kV GAS INSULATED  
SWITCHGEAR  
DATASHEETDocument No.  
B269-999-16-50-DS-0031  
Rev. No. C  
Page 1 of 5

|                |   |                 |                                      |
|----------------|---|-----------------|--------------------------------------|
| <b>Project</b> | Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery | <b>Client</b>   | IOCL REFINERY DIVISION - HEAD OFFICE |
| <b>Unit</b>    | COMMON  | <b>Location</b> | Panipat                              |
|                |   | <b>Job No.</b>  | B269                                 |
|                |   | <b>Unit No.</b> | 999                                  |

## PURCHASER'S DATA

| A Site Conditions      |  |    |   |
|------------------------|--|----|---|
| 1                      | Maximum Ambient Temperature                                | °C | 50  |
| 2                      | Minimum Ambient Temperature                                | °C | 5   |
| 3                      | Desian Ambient Temperature                                 | °C | 45  |
| 4                      | Relative Humiditv  | %  | 90  |
| 5                      | Altitude Above MSL   | m  | 1000  |
| 6                      | Environment  |    | Hot, Humid & Corrosive                        |
| B Operating Conditions |  |    |   |
| 1                      | System Voltage   |    | 220 kV ± TP %                                 |
| 2                      | Frequency  |    | 50 Hz ± 3 %                                   |
| 3                      | Number of Phases   |    | Three   |
| 4                      | System Fault Level   |    | 50KA for 3 Sec                                |
| 5                      | System Earthing  |    | Solidly Earthed                               |
| 6                      | Auxilliary Power Suppy                                     |    |   |
| i.                     | - for space heaters,cubicle lamps etc                      |    | 240 V AC TPN 10 %                             |
| ii                     | - for protection metering and control                      |    | 110 V DC -10/+ 15 %                           |
| iii                    | - circuit breaker spring charging motor                    |    | 110 V DC -10/+ 15 %                           |
| iv                     | - Motor drive for disconnectors and earth switches         |    | 110 V DC -10/+ 15 %                           |
| v                      | - high speed earth switch spring charging motor            |    | 110 V DC -10/+ 15 %                           |
| vi                     | - gas handling and filling unit / cart                     |    | 415 V AC TPN ± 10%                            |
| 7                      | Installation   |    |   |
| i.                     | GIS  |    | Airconditioned                                |
| ii                     | LCC  |    | Airconditioned                                |
| iii                    | CRP  |    | Airconditioned                                |
| C Electrical Data      |  |    |   |
| 1                      | Bus Bar System   |    | Double  |
| 2                      | Bus bar rated current                                      | A  | 2000  |
| 3                      | 1 sec short circuit withstand capacity                     | kA | 50  |
| 4                      | Rated peak withstand current                               | kA | 135   |
| 5                      | Internal arc rating  |    | 50 kA for 0.3                                 |
| 6                      | Circuit Breaker  |    |   |
| i                      | Type of circuit breaker                                    |    | SF6   |
| ii                     | Duty cycle of Circuit Breaker                              |    | 0-3 min-CO-3 min-CO                           |
| iii                    | Breaking capacity  | kA | 50  |
| iv                     | Making capacity  | kA | 135   |
| v                      | CB Operating Mechanism                                     |    | Spring Charged or Electro Hydraulic 6-51-0066 |
| vi                     | Shunt trip coil-1  |    | 110V DC                                       |
|                        | Shunt trip coil -2   |    | 110V DC                                       |
| vii                    | Mechanical indicator for breaker status                    |    | Required                                      |
| viii                   | Pre-insertion resistor                                     |    | Not Required                                  |
| 7                      | Disconnector & Earthing Switch                             |    |   |
| i                      | Operating Machanism  |    | Motorised                                     |
| ii                     | Mechanical indicator for disconnector & earthswitch status |    | Required                                      |
| iii                    | Viewing windows for disconnector and earthswitch           |    | Required                                      |
| iv                     | Mechanical interlock for disconnector & earthswitch        |    | Required                                      |
| v                      | Electrical interlock with associated circuit breaker       |    | Required                                      |
| 8                      | High speed make-proof Earthing switch                      |    |   |

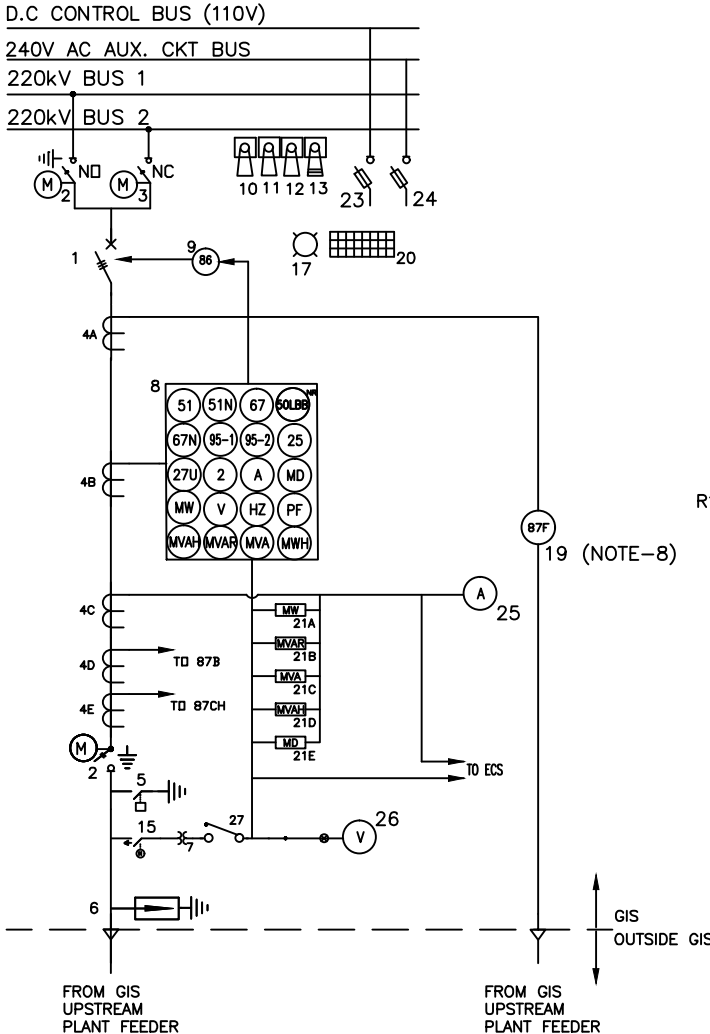
| Rev. No. | Date        | Purpose                          | Prepared By        | Reviewed By  | Approved By  |
|----------|-------------|----------------------------------|--------------------|--------------|--------------|
| C        | 27-SEP-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| B        | 05-JUL-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH TENDER               | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |

|                |   |                 |               |  |      |
|----------------|---|-----------------|---------------|--|------|
| <b>Project</b> | Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery |                 | <b>Client</b> | IOCL REFINERY DIVISION - HEAD OFFICE       |      |
| <b>Unit</b>    | COMMON  | <b>Location</b> | Panipat       | <b>Job No.</b>                             | B269 |
|                |   |                 |               | <b>Unit No.</b>                            | 999  |
| i              | Operating Mechanism   |                 |               | Motorised                                  |      |
| ii             | Mechanical indicator for High speed earthswitch status                                  |                 |               | Required                                   |      |
| iii            | Electrical interlock with associated circuit breaker                                    |                 |               | Required                                   |      |
| <b>D</b>       | <b>Miscellaneous</b>  |                 |               |  |      |
| 1              | Paint Shade   |                 |               | RAL-7032                                   |      |
| 2              | Interface with ECS  |                 |               | Required                                   |      |
| 3              | SF6 Gas monitoring system   |                 |               | Required                                   |      |
| 4              | SF6 Gas Handling /filling unit  |                 |               | Required                                   |      |
| 5              | Spare SF6 gas   |                 |               | Required                                   |      |
| 6              | Quality of spare gas  |                 |               | 10% of total gas as per 6.9.4 of 6-51-0066 |      |
| 7              | Mimic on LV compartment   |                 |               | Required                                   |      |
| 8              | Voltage Detectors   |                 |               | Required                                   |      |

|          |             |                                  |                    |              |              |
|----------|-------------|----------------------------------|--------------------|--------------|--------------|
| C        | 27-SEP-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| B        | 05-JUL-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH TENDER               | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| Rev. No. | Date        | Purpose                          | Prepared By        | Reviewed By  | Approved By  |

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|   |     |          |                    |     |      |       |
|---|-----|----------|--------------------|-----|------|-------|
| PROJECT: PANIPAT REFINERY EXPANSION(P-25)<br>CLIENT: M/S IOCL | REV | DATE     | PURPOSE            | BY  | CHKD | APPRV |
|   | A   | 11.05.20 | ISSUED WITH TENDER | AKG | HK   | HK    |
|   | B   | 05.07.21 | ISSUED WITH TENDER | AKG | HK   | HK    |



- R1  PART OF NUMERICAL RELAY-1  
R2  PART OF NUMERICAL RELAY-2
- NOTES:**
- ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
  - THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
  - ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. R2 METERING SHALL BE A PART OF NUMERICAL RELAY. SEPARATE ANALOGUE METERING DEVICES SHALL ALSO BE PROVIDED AS INDICATED.
  - VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
  - MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC. FOR CRP MIMIC SHALL BE PROVIDED IN RELAY/BCU.
  - THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE TENDER DOCUMENT.
  - THREE CORE PT SHALL BE PROVIDED. PT WITH ACCURACY CLASS 1.0 SHALL BE USED FOR MEASURING, PT WITH ACCURACY CLASS 3P SHALL BE USED FOR PROTECTION & OPEN DELTA PT SHALL BE USED FOR DETECTING EARTH FAULT AND PREVENTION OF FERRO RESONANCE.
  - 87F RELAY OF SAME MAKE/ MODEL SHALL BE LOOSE SUPPLIED BY VENDOR FOR INSTALLATION IN UPSTREAM FEEDER GIS CRP.
  - INTERCONNECTING CABLING BETWEEN GIS, LCC AND CRP SHALL BE SUPPLIED BY VENDOR AND SHALL BE ARMoured CABLE.
  - 220 KV CABLE TERMINATION KITS ARE NOT INCLUDED IN SCOPE OF VENDOR.

| EQUIPMENT DATA |          |     |   |
|----------------|----------|-----|---|
| ITEM NO.       | NEMA NO. | QTY | DESCRIPTION   |
| 1              | 52       | 1   | SF6 CIRCUIT BREAKER (TWO TRIP COILS)  |
| 2              | --       | 2   | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED ONE FOR BUS SIDE ONE FOR LINE SIDE |
| 3              | --       | 1   | 2 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED  |
| 4A             | --       | 3   | CT FOR 87F CLASS PS   |
| 4B             | --       | 3   | CT CLASS-5P10   |
| 4C             | --       | 3   | CT CLASS-1 (MIN. 10VA)  |
| 4D             | --       | 3   | CT FOR 87B CLASS PS   |
| 4E             | --       | 3   | CT FOR 87CH CLASS PS  |
| 5              | --       | 1   | HIGH SPEED MAKE PROOF EARTHING SWITCH   |
| 6              | --       | 1   | SURGE ARRESTOR  |
| 7              | --       | 1   | PT 220/√3/110/√3, WITH 4 POLE MCB (REFER NOTE-07)   |
| 8              | 67       | 1   | DIRECTIONAL IDMTL O/C RELAY   |
|                | 51N      |     | IDMTL E/F RELAY (10-40%)  |
|                | 25       |     | SYNCHRONISING CHECK RELAY   |
|                | 95-1/2   |     | TRIP CIRCUIT SUPERVISION RELAY  |
|                | 27       |     | UNDERVOLTAGE RELAY  |
|                | 2        |     | TIMER   |
|                | 67N      |     | DIRECTIONAL IDMTL E/F RELAY   |
|                | 51V      |     | VOLTAGE RESTRAINED OVERCURRENT RELAY  |
|                | 51       |     | IDMTL O/C RELAY (50-200%)   |
|                | 50LB B   |     | LOCAL BREAKER BACKUP  |
| 9              | 86       | 1   | TRIPPING RELAY - CONVENTIONAL VAJH TYPE   |
| 10             | --       | 1   | UPSTREAM BREAKER TRIP SWITCH (2 POSITION )(STAYPUT & LOCKABLE)  |
| 11             | --       | 6   | CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES   |
| 12             | --       | 1   | LOCAL/OFF/REMOTE SELECTOR SWITCH  |
| 13             | 52C/S    | 1   | BREAKER CONTROL SWITCH (TNC) (LOCKABLE WITH SPRING RETURN TO NEUTRAL) SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION            |
| 14             | --       | 1   | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED                                    |
| 15             | --       | 1   | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED                                    |
| 16             | AS REQD  |     | SF6 GAS MONITORING, ALARMS AND INDICATIONS  |
| 17             | AS REQD  |     | CLUSTER LED TYPE INDICATION LAMP  |
| 18             | AS REQD  |     | AUXILIARY RELAY   |
| 19             | 87F      | 2   | FEEDER DIFFERENTIAL PROTECTION RELAY  |
| 20             | AS REQD  |     | WINDOW ALARM ANNUNCIATIONS  |
| 21A            | --       | 1   | MW METER  |
| 21B            | --       | 1   | MVAR METER  |
| 21C            | --       | 1   | MVA METER   |
| 21D            | --       | 1   | MVAH METER  |
| 21E            | --       | 1   | MAXIMUM DEMAND METER  |
| 22             | 2        | SET | CUBICLE LAMP WITH MCB, DOOR SWITCH, PANEL SPACE HEATER & 3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP  |
| 23             | --       | 2   | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY FOR LCC & CRP   |
| 24             | --       | 2   | LV POWER SUPPLY SWITCH FUSE FOR LCC & CRP   |
| 25             | --       | 3   | AMMETER   |
| 26             | --       | 3   | VOLTMETER   |
| 27             | --       | 3   | 4 POLE MCB, 10A, (FOR EACH PT CORE)   |



**220KV GIS DATA SHEET**  
HARDWARE DATASHEET FOR INCOMER FROM PLANT FEEDER

|                        |     |
|------------------------|-----|
| DATA SHEET             | REV |
| B269-999-16-50-DS-0036 | B   |
| Sht.1 OF 1             |     |

|      |           |                                  |          |         |          |
|------|-----------|----------------------------------|----------|---------|----------|
| B    | 9/27/2021 | REVISED AND REISSUED WITH TENDER | AKG      | HK      | HK       |
| A    | 7/5/2021  | ISSUED WITH TENDER               | AKG      | HK      | HK       |
| Rev. | Date      |                                  | Prepared | Checked | Approved |

|                  |                |                    |                    |                   |                |
|------------------|----------------|--------------------|--------------------|-------------------|----------------|
| Project          | P25 PANIPAT    | Unit               | P25                | Client            | IOCL-PR        |
| Switchgear No.   |                | Location           | OUTDOOR SWITCHYARD | Auto/ Manual Xfr. | Not Applicable |
| Voltage          | 220 kV         | Curent             | 2000 Amps          | Fault Level       | 50 kA (3 Sec)  |
| Bus Differential | Not Applicable | Bus Diff. CT Ratio | Not Applicable     |                   |                |

| S.No. | Feeder Nameplate Inscription |              |   |               | Bus Section |     |       | Breaker Rating/<br>Feeder<br>Designation | CT Primary Rating (A)* |            |   |   | Cable Details |      |      | Reference Datasheet                          |                        | Remarks |
|-------|------------------------------|--------------|---|---------------|-------------|-----|-------|--|------------------------|------------|---|---|---------------|------|------|--|------------------------|---------|
|       | Panel No. @                  | Feeder No. # | Feeder Description                                | Rating (MVA)# | Left        | Mid | Right |  | Metering               | Protection |   |   | Run           | Core | Size | EIL Hardware<br>Datasheet<br>B269-999-16-50- | Vendor<br>Scheme No. @ |         |
| 1     |                              |              | HV-100101 220kV GIS Outdoor IBP<br>(With Line PT) |               |             |     | 2000  | 2000                                     | 2000                   | 2000       | - | 3 | 1             | 1200 | 0037 |  | Note-4 / 6             |         |
| 2     |                              |              | HV-100102 220kV GIS Outdoor IBP<br>(With Line PT) |               |             |     | 2000  | 2000                                     | 2000                   | 2000       | - | 3 | 1             | 1200 | 0037 |  | Note-4 / 6             |         |

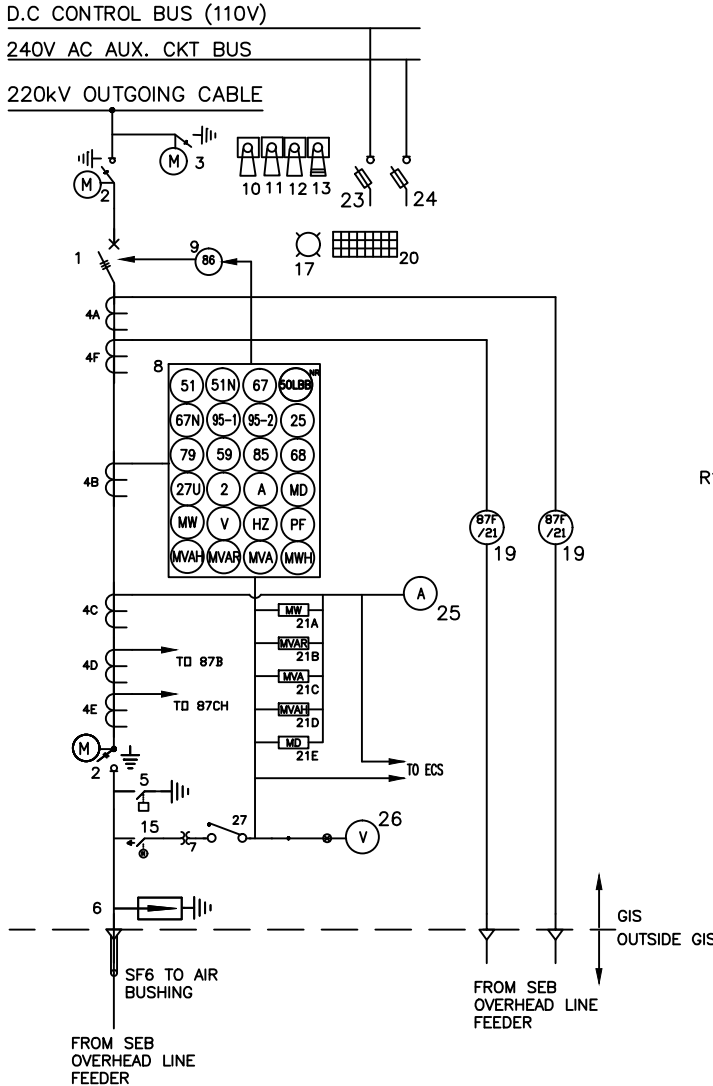
**Notes :**

1. '\*' CT primary current ratings indicated are tentative and shall be finalised during drawing approval stage without any cost implication. CT secondary shall be 1 Amps for all.
2. '#' These shall be finalised during drawing approval stage and shall not have any cost implication.
3. '@' Data to be furnished by Vendor.
4. Total number of runs collectively for R,Y and B phase are indicated. Cable runs and cable sizes are indicative and actual cable size shall be informed during review of documents post order without any time or cost implication.
5. Gas Insulated surge arrester shall be provided in incomers and all outgoing feeders. Line PT and Bus PT shall also be Gas Insulated Type.
6. Incoming connection to IBP shall be from over head lines

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PROJECT: PANIPAT REFINERY EXPANSION(P-25)  
 CLIENT: M/S IOCL

| REV | DATE     | PURPOSE            | BY  | CHKD | APPRV |
|-----|----------|--------------------|-----|------|-------|
| A   | 11.05.20 | ISSUED WITH TENDER | AKG | HK   | HK    |
| B   | 05.07.21 | ISSUED WITH TENDER | AKG | HK   | HK    |



R1 PART OF NUMERICAL RELAY-1  
 R2 PART OF NUMERICAL RELAY-2

- NOTES:**
- ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
  - THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
  - ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY. SEPARATE ANALOGUE METERING DEVICES SHALL ALSO BE PROVIDED AS INDICATED.
  - VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL..
  - MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC. FOR CRP MIMIC SHALL BE PROVIDED IN RELAY/BCU.
  - THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE TENDER DOCUMENT.
  - THREE CORE PT SHALL BE PROVIDED. PT WITH ACCURACY CLASS 1.0 SHALL BE USED FOR MEASURING, PT WITH ACCURACY CLASS 3P SHALL BE USED FOR PROTECTION & OPEN DELTA PT SHALL BE USED FOR DETECTING EARTH FAULT AND PREVENTION OF FERRO RESONANCE.
  - 87F/21 RELAY OF SAME MAKE/ MODEL SHALL BE LOOSE SUPPLIED BY VENDOR FOR INSTALLATION (BY OTEHRS) IN SEB SWITCHYARD CRP.
  - INTERCONNECTING CABLING BETWEEN GIS, LCC AND CRP SHALL BE SUPPLIED BY VENDOR AND SHALL BE ARMoured CABLE.
  - 220 KV CABLE TERMINATION KITS ARE NOT INCLUDED IN SCOPE OF VENDOR.

**EQUIPMENT DATA**

| ITEM NO. | NEMA NO. | QTY | DESCRIPTION   |
|----------|----------|-----|---|
| 1        | 52       | 1   | SF6 CIRCUIT BREAKER (TWO TRIP COILS)  |
| 2        | --       | 2   | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED ONE FOR BUS SIDE ONE FOR LINE SIDE |
| 3        | --       | 1   | 2 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ISOLATED/EARTHED                                       |
| 4A       | --       | 3   | CT FOR 87F/21 CLASS PS  |
| 4B       | --       | 3   | CT CLASS-5P10   |
| 4C       | --       | 3   | CT CLASS-1 (MIN. 10VA)  |
| 4D       | --       | 3   | CT FOR 87B CLASS PS   |
| 4E       | --       | 3   | CT FOR 87CH CLASS PS  |
| 4F       | --       | 3   | CT FOR 87F/21 CLASS PS  |
| 5        | --       | 1   | HIGH SPEED MAKE PROOF EARTHING SWITCH   |
| 6        | --       | 1   | SURGE ARRESTOR  |
| 7        | --       | 1   | PT 220/√3/110/√3, WITH 4 POLE MCB (REFER NOTE-07)   |
| 8        | 87       | 2   | DIRECTIONAL IDMTL O/C RELAY   |
|          | 51N      |     | IDMTL E/F RELAY (10-40%)  |
|          | 25       |     | SYNCHRONISING CHECK RELAY   |
|          | 95-1/2   |     | TRIP CIRCUIT SUPERVISION RELAY  |
|          | 59       |     | OVERVOLTAGE RELAY   |
|          | 27       |     | UNDERVOLTAGE RELAY  |
|          | 79       |     | AUTO RECLOSE FUNCTION   |
|          | 85       |     | CARRIER AIDED INTER TRIP  |
|          | 68       |     | BLOCKING RELAY  |
|          | 2        |     | TIMER   |
|          | 87N      |     | DIRECTIONAL IDMTL E/F RELAY   |
|          | 51V      |     | VOLTAGE RESTRAINED OVERCURRENT RELAY  |
|          | 51       |     | IDMTL O/C RELAY (50-200%)   |
|          | 50LB     |     | LOCAL BREAKER BACKUP  |
| 9        | 86       | 1   | TRIPPING RELAY - CONVENTIONAL TYPE UPSTREAM BREAKER TRIP SWITCH   |
| 10       | --       | 1   | (2 POSITION )(STAYPUT & LOCKABLE)   |
| 11       | --       | 6   | CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES   |
| 12       | --       | 1   | LOCAL/OFF/REMOTE SELECTOR SWITCH  |
| 13       | 52C/S    | 1   | BREAKER CONTROL SWITCH (TNC) (LOCKABLE WITH SPRING RETURN TO NEUTRAL)   |
| 14       | --       | 1   | SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION  |
| 15       | --       | 1   | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED                                    |
| 16       | AS REQD  |     | SF6 GAS MONITORING, ALARMS AND INDICATIONS  |
| 17       | AS REQD  |     | CLUSTER LED TYPE INDICATION LAMP  |
| 18       | AS REQD  |     | AUXILIARY RELAY   |
| 19       | 87F/21   | 4   | FEEDER DIFFERENTIAL PROTECTION RELAY OR DISTANCE PROTECTION RELAY (EACH OF TWO DIFFERENT MAKES) (REFER NOTE-8)                                      |
| 20       | AS REQD  |     | WINDOW ALARM ANNUNCIATIONS  |
| 21A      | --       | 1   | MW METER  |
| 21B      | --       | 1   | MVAR METER  |
| 21C      | --       | 1   | MVA METER   |
| 21D      | --       | 1   | MVAH METER  |
| 21E      | --       | 1   | MAXIMUM DEMAND METER  |
| 22       | 2 SET    |     | CUBICLE LAMP WITH MCB, DOOR SWITCH, PANEL SPACE HEATER & 3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP  |
| 23       | --       | 2   | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY FOR LCC & CRP   |
| 24       | --       | 2   | LV POWER SUPPLY SWITCH FUSE FOR LCC & CRP   |
| 25       | --       | 3   | AMMETER   |
| 26       | --       | 3   | VOLTMETER   |
| 27       | --       | 3   | 4 POLE MCB, 10A, (FOR EACH PT CORE)   |
| 28       | --       | 1   | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED                                    |



ENGINEERS INDIA LIMITED  
 NEW DELHI

**220KV GIS DATA SHEET**  
 HARDWARE DATASHEET FOR INCOMER FROM OVERHEAD LINE

|                        |     |
|------------------------|-----|
| DATA SHEET             | REV |
| B269-999-16-50-DS-0037 | B   |
| Sht.1 OF 1             |     |

|             |             |                                  |                 |                |                 |
|-------------|-------------|----------------------------------|-----------------|----------------|-----------------|
| C           | 9/27/2021   | REVISED AND REISSUED WITH TENDER | AKG             | HK             | HK              |
| B           | 7/5/2021    | REVISED AND REISSUED WITH TENDER | AKG             | HK             | HK              |
| <b>Rev.</b> | <b>Date</b> |                                  | <b>Prepared</b> | <b>Checked</b> | <b>Approved</b> |

|                         |             |                           |                       |                          |                |
|-------------------------|-------------|---------------------------|-----------------------|--------------------------|----------------|
| <b>Project</b>          | P25 PANIPAT | <b>Unit</b>               | SUBSTATION            | <b>Client</b>            | IOCL-PR        |
| <b>Switchgear No.</b>   | HV-100103   | <b>Location</b>           | Substation-100 (MRSS) | <b>Auto/ Manual Xfr.</b> | Not Applicable |
| <b>Voltage</b>          | 220 kV      | <b>Curent</b>             | 2000 Amps             | <b>Fault Level</b>       | 50 kA (3 Sec)  |
| <b>Bus Differential</b> | Required    | <b>Bus Diff. CT Ratio</b> | 2000/1                |                          |                |

| S.No. | Feeder Nameplate Inscription |              |   |               | Bus Section |     |       | Breaker Rating/<br>Feeder<br>Designation | CT Primary Rating (A)* |              |                                  |                   | Cable Details |      |      | Reference Datasheet                          |                       | Remarks |
|-------|------------------------------|--------------|---|---------------|-------------|-----|-------|--|------------------------|--------------|----------------------------------|-------------------|---------------|------|------|--|-----------------------|---------|
|       | Panel No. @                  | Feeder No. # | Feeder Description                          | Rating (MVA)# | Left        | Mid | Right |  | Metering               | Protection   |                                  |                   | Run           | Core | Size | EIL Hardware<br>Datasheet<br>B269-999-16-50- | Vendor<br>Scheme No.@ |         |
|       |                              |              |   |               |             |     |       |  |                        | O/C,S/C, E/F | Trafo/<br>Feeder<br>Differential | REF<br>Protection |               |      |      |  |                       |         |
| 1     |                              |              | Incomer from PR 220kV GIS<br>(With Line PT) | 125           | 1           |     |       | 2000                                     | 2000                   | 2000         | 2000                             | -                 | 3             | 1    | 400  | 0036   |                       | Note-4  |
| 2     |                              |              | Incomer from PR 220kV GIS<br>(With Line PT) | 125           |             |     | 1     | 2000                                     | 2000                   | 2000         | 2000                             | -                 | 3             | 1    | 400  | 0036   |                       | Note-4  |
| 3     |                              |              | Incomer from PR IBP<br>(With Line PT)       | 270           | 1           |     |       | 2000                                     | 2000                   | 2000         | 2000                             | -                 | 3             | 1    | 1200 | 0036   |                       | Note-4  |
| 4     |                              |              | Incomer from PR IBP<br>(With Line PT)       | 270           |             |     | 1     | 2000                                     | 2000                   | 2000         | 2000                             | -                 | 3             | 1    | 1200 | 0036   |                       | Note-4  |
| 5     |                              |              | Bus Coupler 1A-2A                           |               | 1           |     |       | 2000                                     | 2000                   | 2000         | -                                | -                 | -             | -    | -    | 0038   |                       |         |
| 6     |                              |              | Bus Coupler 1B-2B                           |               |             |     | 1     | 2000                                     | 2000                   | 2000         | -                                | -                 | -             | -    | -    | 0038   |                       |         |
| 7     |                              |              | Bus Sectionalizer 1A-1B                     |               |             |     | 1     | 2000                                     | 2000                   | 2000         | -                                | -                 | -             | -    | -    | 0038   |                       |         |
| 8     |                              |              | Bus Sectionalizer 2A-2B                     |               |             |     | 1     | 2000                                     | 2000                   | 2000         | -                                | -                 | -             | -    | -    | 0038   |                       |         |
| 9     |                              |              | Bus PT 1A                                   |               | 1           |     |       | -  | -                      | -            | -                                | -                 | -             | -    | -    | 0039   |                       | Note-7  |
| 10    |                              |              | Bus PT 1B                                   |               | 1           |     |       | -  | -                      | -            | -                                | -                 | -             | -    | -    | 0039   |                       | Note-7  |
| 11    |                              |              | Bus PT 2A                                   |               |             |     | 1     | -  | -                      | -            | -                                | -                 | -             | -    | -    | 0039   |                       | Note-7  |
| 12    |                              |              | Bus PT 2B                                   |               |             |     | 1     | -  | -                      | -            | -                                | -                 | -             | -    | -    | 0039   |                       | Note-7  |
| 13    |                              |              | Transformer Feeder (TR-100011)              | 50            | 1           |     |       | 1250A                                    | 200                    | 200          | 200                              | 200               | 3             | 1    | 400  | 0040   |                       | Note-4  |

|             |             |                                  |                 |                |                 |
|-------------|-------------|----------------------------------|-----------------|----------------|-----------------|
| C           | 9/27/2021   | REVISED AND REISSUED WITH TENDER | AKG             | HK             | HK              |
| B           | 7/5/2021    | REVISED AND REISSUED WITH TENDER | AKG             | HK             | HK              |
| <b>Rev.</b> | <b>Date</b> |                                  | <b>Prepared</b> | <b>Checked</b> | <b>Approved</b> |

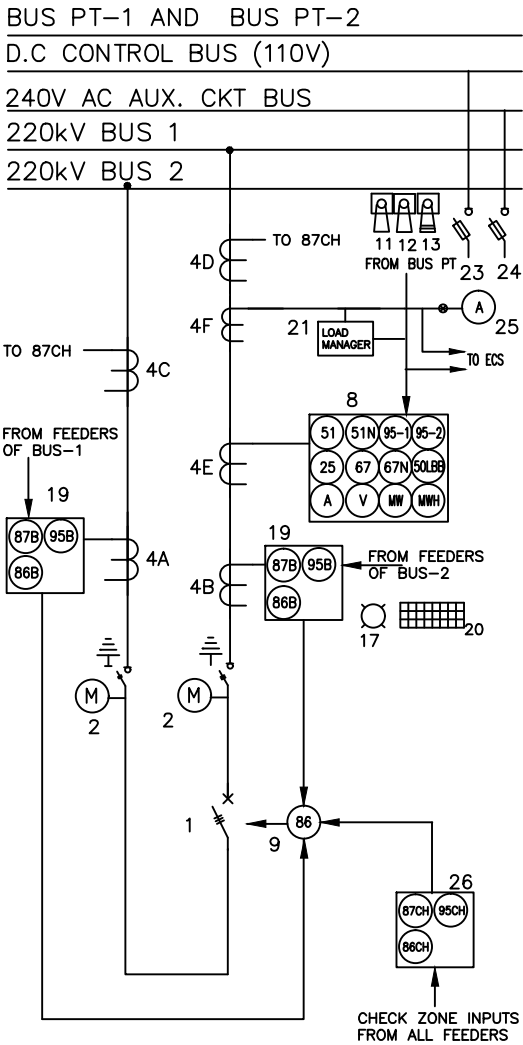
|                         |             |                           |                       |                          |                |
|-------------------------|-------------|---------------------------|-----------------------|--------------------------|----------------|
| <b>Project</b>          | P25 PANIPAT | <b>Unit</b>               | SUBSTATION            | <b>Client</b>            | IOCL-PR        |
| <b>Switchgear No.</b>   | HV-100103   | <b>Location</b>           | Substation-100 (MRSS) | <b>Auto/ Manual Xfr.</b> | Not Applicable |
| <b>Voltage</b>          | 220 kV      | <b>Curent</b>             | 2000 Amps             | <b>Fault Level</b>       | 50 kA (3 Sec)  |
| <b>Bus Differential</b> | Required    | <b>Bus Diff. CT Ratio</b> | 2000/1                |                          |                |

| S.No. | Feeder Nameplate Inscription |              |                                |               | Bus Section |     |       | Breaker Rating/<br>Feeder<br>Designation | CT Primary Rating (A)* |              |                                  |                   | Cable Details |      |      | Reference Datasheet                          |                       | Remarks |
|-------|------------------------------|--------------|--------------------------------|---------------|-------------|-----|-------|--|------------------------|--------------|----------------------------------|-------------------|---------------|------|------|--|-----------------------|---------|
|       | Panel No. @                  | Feeder No. # | Feeder Description             | Rating (MVA)# | Left        | Mid | Right |  | Metering               | Protection   |                                  |                   | Run           | Core | Size | EIL Hardware<br>Datasheet<br>B269-999-16-50- | Vendor<br>Scheme No.@ |         |
|       |                              |              |                                |               |             |     |       |  |                        | O/C,S/C, E/F | Trafo/<br>Feeder<br>Differential | REF<br>Protection |               |      |      |  |                       |         |
| 14    |                              |              | Transformer Feeder (TR-100012) | 50            | 1           |     |       | 1250A                                    | 200                    | 200          | 200                              | 200               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 15    |                              |              | Transformer Feeder (TR-100013) | 125           |             |     | 1     | 1250A                                    | 400                    | 400          | 400                              | 400               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 16    |                              |              | Transformer Feeder (TR-100014) | 125           |             |     | 1     | 1250A                                    | 400                    | 400          | 400                              | 400               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 17    |                              |              | Transformer Feeder (TR-100015) | 125           |             |     | 1     | 1250A                                    | 400                    | 400          | 400                              | 400               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 18    |                              |              | Transformer Feeder (TR-100016) | 125           |             |     | 1     | 1250A                                    | 400                    | 400          | 400                              | 400               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 19    |                              |              | Transformer Feeder (Spare)     | 125           |             |     | 1     | 1250A                                    | 400                    | 400          | 400                              | 400               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 20    |                              |              | Transformer Feeder (Spare)     | 50            | 1           |     |       | 1250A                                    | 200                    | 200          | 200                              | 200               | 3             | 1    | 400  | 0040   |                       | Note-4  |
| 21    |                              |              | Transformer Feeder (Spare)     | 125           |             |     | 1     | 1250A                                    | 200                    | 200          | 200                              | 200               | 3             | 1    | 400  | 0040   |                       | Note-4  |

- Notes :**
- 1 \*\* CT primary current ratings indicated are tentative and shall be finalised during drawing approval stage without any cost implication. CT secondary shall be 1 Amps for all.
  - 2 # These shall be finalised during drawing approval stage and shall not have any cost implication.
  - 3 @ Data to be furnished by Vendor.
  - 4 Total number of runs collectively for R,Y and B phase are indicated. Cable runs and cable sizes are indicative and actual cable size shall be informed during review of documents post order without any time or cost implication.
  - 5 Gas Insulated surge arrestor shall be provided in incomers and all outgoing feeders. Line PT and Bus PT shall also be Gas Insulated Type.
  - 6 Bus differential protection and Bus wire check supervision shall be provided for the switchboard including corresponding CTs.
  - 7 Independent Bus PT panel shall be provided for all the four buses of the Double Bus GIS switchboard.

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|   |     |          |                    |     |      |       |
|---|-----|----------|--------------------|-----|------|-------|
| PROJECT: PANIPAT REFINERY EXPANSION(P-25)<br>CLIENT: M/S IOCL | REV | DATE     | PURPOSE            | BY  | CHKD | APPRV |
|   | A   | 11.05.20 | ISSUED WITH TENDER | AKG | HK   | HK    |
|   | B   | 05.07.21 | ISSUED WITH TENDER | AKG | HK   | HK    |



- R1  PART OF NUMERICAL RELAY-1
- R2  PART OF NUMERICAL RELAY-2
- R3  PART OF NUMERICAL RELAY-3

- NOTES:
- ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
  - THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
  - ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY. SEPARATE ANALOGUE METERING DEVICES SHALL ALSO BE PROVIDED AS INDICATED.
  - VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHBOARD VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
  - MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC. FOR CRP MIMIC SHALL BE PROVIDED IN RELAY/BCU.
  - THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE SPECIFICATION.

### EQUIPMENT DATA

| ITEM NO. | NEMA NO. | QTY   | DESCRIPTION  |
|----------|----------|-------|--|
| 1        | 52       | 1     | SF6 CIRCUIT BREAKER (TWO TRIP COIL)  |
| 2        | --       | 2     | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED |
| 3        | --       | --    | DELETED  |
| 4A       | --       | 3     | CT FOR 87B CLASS PS  |
| 4B       | --       | 3     | CT FOR 87B CLASS PS  |
| 4C       | --       | 3     | CT FOR 87CH CLASS PS   |
| 4D       | --       | 3     | CT FOR 87CH CLASS PS   |
| 4E       | --       | 3     | CT CLASS-5P10  |
| 4F       | --       | 3     | CT CLASS-1 (MIN. 10VA)   |
| 5        | --       | --    | DELETED  |
| 6        | --       | --    | DELETED  |
| 7        | --       | --    | DELETED  |
| 8        | 67       | 1     | DIRECTIONAL IDMTL O/C RELAY  |
| 51N      |          |       | IDMTL E/F RELAY (10-40%)   |
| 25       |          |       | SYNCHRONISING CHECK RELAY  |
| 95-1/2   |          |       | TRIP CIRCUIT SUPERVISION RELAY   |
| 67N      |          |       | DIRECTIONAL IDMTL E/F RELAY  |
| 51       |          |       | IDMTL O/C RELAY (50-200%)  |
| 50LB     |          |       | LOCAL BREAKER BACKUP   |
| 9        | 86       | 1     | TRIPPING RELAY - CONVENTIONAL VAJH TYPE  |
| 10       | --       | --    | DELETED  |
| 11       | --       | 4     | CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES  |
| 12       | --       | 1     | LOCAL/OFF/REMOTE SELECTOR SWITCH   |
| 13       | 52C/S    | 1     | BREAKER CONTROL SWITCH (TNC) (LOCKABLE WITH SPRING RETURN TO NEUTRAL)  |
| 14       | --       | 1     | SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION   |
| 15       | --       | --    | DELETED  |
| 16       | AS REQD  | --    | SF6 GAS MONITORING, ALARMS AND INDICATIONS   |
| 17       | AS REQD  | --    | CLUSTER LED TYPE INDICATION LAMP   |
| 18       | AS REQD  | --    | AUXILIARY RELAY  |
| 19       | 87B      | 2     | BUSBAR DIFFERENTIAL PROTECTION RELAY LOW IMPEDANCE TYPE WITH MANUAL BYPASS                                       |
| 95B      |          |       | CT SUPERVISION RELAY   |
| 20       | AS REQD  | --    | WINDOW ALARM ANNUNCIATIONS   |
| 21       | --       | 1     | LOAD MANAGER   |
| 22       | --       | 2 SET | CUBICLE LAMP WITH MCB, DOOR SWITCH, PANEL SPACE HEATER & 3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP           |
| 23       | --       | 2     | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY FOR LCC & CRP  |
| 24       | --       | 2     | LV POWER SUPPLY SWITCH FUSE FOR LCC & CRP  |
| 25       | --       | 1     | AMMETER WITH 4 WAY A-S-S   |
| 26       | 87CH     | 1     | BUSBAR DIFFERENTIAL PROTECTION RELAY LOW IMPEDANCE TYPE WITH MANUAL BYPASS                                       |
| 95CH     |          |       | CT SUPERVISION RELAY   |



ENGINEERS INDIA LIMITED  
NEW DELHI

220KV GIS DATA SHEET  
HARDWARE DATASHEET FOR BUS COUPLER/ BUS SECTIONALIZER

DATA SHEET  
B269-999-16-50-DS-0038  
Sht.1 OF 1

REV  
B

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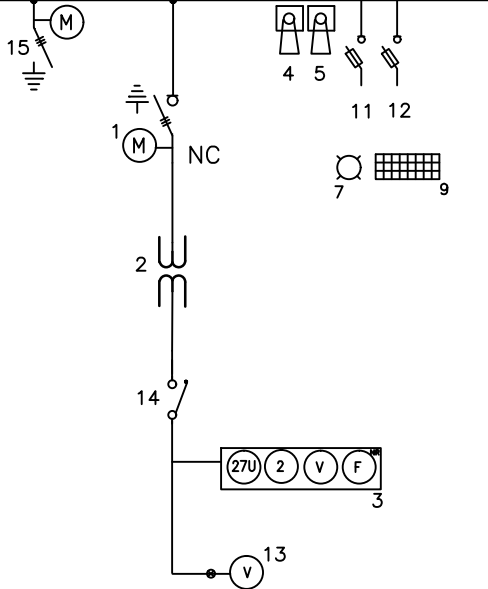
PROJECT: PANIPAT REFINERY EXPANSION(P-25)  
 CLIENT: M/S IOCL

| REV | DATE     | PURPOSE            | BY  | CHKD | APPRV |
|-----|----------|--------------------|-----|------|-------|
| A   | 11.05.20 | ISSUED WITH TENDER | AKG | HK   | HK    |
| B   | 05.07.21 | ISSUED WITH TENDER | AKG | HK   | HK    |

D.C CONTROL BUS (110V)

240V AC AUX. CKT BUS

220KV GIS BUS



| EQUIPMENT DATA |          |         |  |
|----------------|----------|---------|--|
| ITEM NO.       | NEMA NO. | QTY     | DESCRIPTION  |
| 1              | --       | 1       | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED |
| 2              | --       | --      | PT 220/√3/110/√3, WITH 4 POLE MCB  |
| 3              | 27       |         | UNDervOLTAGE RELAY   |
|                | 2        |         | TIMER  |
| 4              | --       | 2       | CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES  |
| 5              | --       | 1       | LOCAL/OFF/REMOTE SELECTOR SWITCH   |
| 6              | --       | AS REQD | SF6 GAS MONITORING, ALARMS AND INDICATIONS   |
| 7              | --       | AS REQD | CLUSTER LED TYPE INDICATION LAMP   |
| 8              | --       | AS REQD | AUXILIARY RELAY  |
| 9              | --       | AS REQD | WINDOW ALARM ANNUNCIATIONS   |
| 10             | --       | 2 SET   | CUBICLE LAMP WITH MCB, DOOR SWITCH, PANEL SPACE HEATER & 3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP           |
| 11             | --       | 2       | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY FOR LCC & CRP  |
| 12             | --       | 2       | LV POWER SUPPLY SWITCH FUSE FOR LCC & CRP  |
| 13             | --       | 1       | VOLTMETER WITH 4 WAY V-S-S   |
| 14             | --       | 3       | 4P MCB, 10A (FOR EACH CORE) ON SECONDARY SIDE OF PT  |
| 15             | --       | 1       | 2 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ISOLATED/EARTHED    |

R1  PART OF NUMERICAL RELAY

NOTES:

- THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
- ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY. SEPARATE ANALOGUE METERING DEVICES SHALL ALSO PROVIDE AS INDICATED.
- VA BURDEN OF PT SHALL BE DECIDED BY THE SWITCHBOARD VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
- INDEPENDENT BUS PT PANEL SHALL BE PROVIDED FOR BOTH THE BUSES OF THE DOUBLE BUS GIS SWITCHBOARD.
- MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC. FOR CRP MIMIC SHALL BE PROVIDED IN RELAY/BCU.
- THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE SPECIFICATION.
- THREE CORE PT SHALL BE PROVIDED. PT WITH ACCURACY CLASS 1.0 SHALL BE USED FOR MEASURING, PT WITH ACCURACY CLASS 3P SHALL BE USED FOR PROTECTION & OPEN DELTA PT SHALL BE USED FOR DETECTING EARTH FAULT AND PREVENTION OF FERRO RESONANCE.
- DUAL CORE PT SHALL BE PROVIDED. PT WITH ACCURACY CLASS 0.2 SHALL BE USED FOR MEASUREMENT AT ECS, SCAP & VOLTMETER. PT WITH ACCURACY CLASS 3P SHALL BE USED FOR PROTECTION.



ENGINEERS INDIA LIMITED  
 NEW DELHI

220KV GIS DATA SHEET  
 HARDWARE DATASHEET FOR BUS PT

| DATA SHEET                           | REV |
|--------------------------------------|-----|
| B269-999-16-50-DS-0039<br>Sht.1 OF 1 | B   |

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|   |     |          |                    |     |      |       |
|---|-----|----------|--------------------|-----|------|-------|
| PROJECT: PANIPAT REFINERY EXPANSION(P-25)<br>CLIENT: M/S IOCL | REV | DATE     | PURPOSE            | BY  | CHKD | APPRV |
|   | A   | 11.05.20 | ISSUED WITH TENDER | AKG | HK   | HK    |
|   | B   | 05.07.21 | ISSUED WITH TENDER | AKG | HK   | HK    |

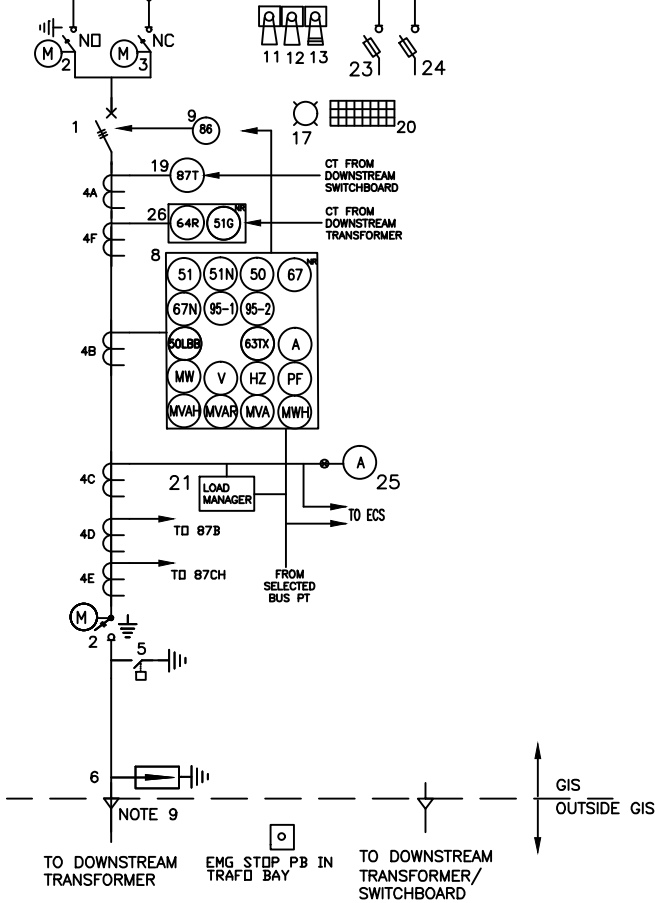
**BUS PT-1 AND BUS PT-2**

**D.C CONTROL BUS (110V)**

**240V AC AUX. CKT BUS**

**220kV BUS 1**

**220kV BUS 2**



- R1  PART OF NUMERICAL RELAY-1
- R2  PART OF NUMERICAL RELAY-2
- R3  PART OF NUMERICAL RELAY-3

- NOTES:**
- ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
  - THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
  - ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY. SEPARATE ANALOGUE METERING DEVICES SHALL ALSO BE PROVIDED AS INDICATED.
  - VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL..
  - MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC. FOR CRP MIMIC SHALL BE PROVIDED IN RELAY/BCU.
  - THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE TENDER DOCUMENT.
  - RELAY FOR 87T AND 64R SHALL BE SEPARATE.
  - INTERCONNECTING CABLING BETWEEN GIS, LCC AND CRP SHALL BE SUPPLIED BY VENDOR AND SHALL BE ARMoured CABLE.
  - 220 KV CABLE TERMINATION KITS ARE NOT INCLUDED IN SCOPE OF VENDOR.

**EQUIPMENT DATA**

| ITEM NO. | NEMA NO. | QTY     | DESCRIPTION   |
|----------|----------|---------|---|
| 1        | 52       | 1       | SF6 CIRCUIT BREAKER (TWO TRIP COILS)  |
| 2        | --       | 2       | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED ONE FOR BUS SIDE ONE FOR LINE SIDE |
| 3        | --       | 1       | 2 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED  |
| 4A       | --       | 3       | CT FOR 87T CLASS PS   |
| 4B       | --       | 3       | CT CLASS-5P10   |
| 4C       | --       | 3       | CT CLASS-1 (MIN. 10VA)  |
| 4D       | --       | 3       | CT FOR 87B CLASS PS   |
| 4E       | --       | 3       | CT FOR 87CH CLASS PS  |
| 4F       | --       | 3       | CT FOR 64R CLASS PS   |
| 5        | --       | 1       | HIGH SPEED MAKE PROOF EARTHING SWITCH   |
| 6        | --       | 1       | SURGE ARRESTOR  |
| 7        | --       | --      | DELETED   |
| 8        | 51       | 1       | IDMTL O/C RELAY (50-200%)   |
|          | 51N      |         | IDMTL E/F RELAY (10-40%)  |
|          | 95-1/2   |         | TRIP CIRCUIT SUPERVISION RELAY  |
|          | 67       |         | DIRECTIONAL IDMTL O/C RELAY   |
|          | 67N      |         | DIRECTIONAL IDMTL E/F RELAY   |
|          | 50       |         | INSTANTANEOUS O/C RELAY   |
|          | 63TX     |         | TRANSFORMER TROUBLE RELAY   |
| 9        | 86       | 1       | TRIPPING RELAY - CONVENTIONAL VAJH TYPE   |
| 10       | --       |         | DELETED   |
| 11       | --       | 6       | CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES   |
| 12       | --       | 1       | LOCAL/OFF/REMOTE SELECTOR SWITCH  |
| 13       | 52C/S    | 1       | BREAKER CONTROL SWITCH (TNC) (LOCKABLE WITH SPRING RETURN TO NEUTRAL)   |
| 14       | --       | 1       | SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION  |
| 15       | --       |         | DELETED   |
| 16       | --       | AS REQD | SF6 GAS MONITORING, ALARMS AND INDICATIONS  |
| 17       | --       | AS REQD | CLUSTER LED TYPE INDICATION LAMP  |
| 18       | --       | AS REQD | AUXILIARY RELAY   |
| 19       | 87T      | 1       | TRANSFORMER DIFFERENTIAL PROTECTION RELAY   |
| 20       | --       | AS REQD | WINDOW ALARM ANNUNCIATIONS  |
| 21       | --       | 1       | LOAD MANAGER  |
| 22       | --       | 2 SET   | CUBICLE LAMP WITH MCB, DOOR SWITCH, PANEL SPACE HEATER & 3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP  |
| 23       | --       | 2       | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY FOR LCC & CRP   |
| 24       | --       | 2       | LV POWER SUPPLY SWITCH FUSE FOR LCC & CRP   |
| 25       | --       | 1       | AMMETER WITH 4 WAY A-S-S  |
| 26       | 64R      | 1       | RESTRICTED EARTH FAULT RELAY  |
|          | 51G      |         | IDMTL BACK UP EARTH FAULT RELAY   |



ENGINEERS INDIA LIMITED  
NEW DELHI

**220KV GIS DATA SHEET**

HARDWARE DATASHEET FOR OUTGOING TRANSFORMER FEEDER

DATA SHEET

REV

B269-999-16-50-DS-0040

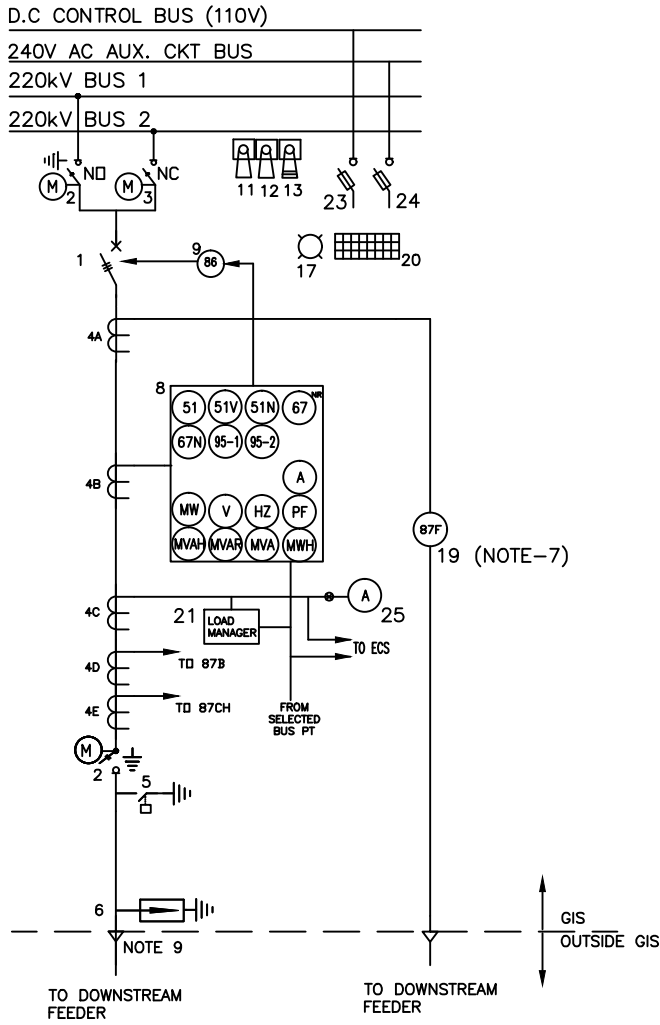
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Sht.1 OF 1

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|   |     |          |                    |     |      |       |
|---|-----|----------|--------------------|-----|------|-------|
| PROJECT: PANIPAT REFINERY EXPANSION(P-25)<br>CLIENT: M/S IOCL | REV | DATE     | PURPOSE            | BY  | CHKD | APPRV |
|   | A   | 11.05.20 | ISSUED WITH TENDER | AKG | HK   | HK    |
|   | B   | 05.07.21 | ISSUED WITH TENDER | AKG | HK   | HK    |

**BUS PT-1 AND BUS PT-2**



R1  PART OF NUMERICAL RELAY-1  
R2  PART OF NUMERICAL RELAY-2

- NOTES:**
1. ANTI-PUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
  2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
  3. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY. SEPARATE ANALOGUE METERING DEVICES SHALL ALSO BE PROVIDED AS INDICATED.
  4. VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL..
  5. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC. FOR CRP MIMIC SHALL BE PROVIDED IN RELAY/BCU.
  6. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE TENDER DOCUMENT.
  7. 87F RELAY OF SAME MAKE/ MODEL SHALL BE LOOSE SUPPLIED BY VENDOR FOR INSTALLATION IN DOWNSTREAM SWITCHBOARD.
  8. INTERCONNECTING CABLING BETWEEN GIS, LCC AND CRP SHALL BE SUPPLIED BY VENDOR AND SHALL BE ARMOURD CABLE.
  9. 220 KV CABLE TERMINATION KITS ARE NOT INCLUDED IN SCOPE OF VENDOR.

**EQUIPMENT DATA**

| ITEM NO. | NEMA NO. | QTY     | DESCRIPTION   |
|----------|----------|---------|---|
| 1        | 52       | 1       | SF6 CIRCUIT BREAKER (TWO TRIP COIL)   |
| 2        | --       | 2       | 3 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED/EARTHED ONE FOR BUS SIDE ONE FOR LINE SIDE |
| 3        | --       | 1       | 2 POSN. DISCONNECTOR SWITCH WITH MOTORIZED/MANUAL OPERATION & MECHANICAL POSITION INDICATOR -ON/ISOLATED  |
| 4A       | --       | 3       | CT FOR 87F CLASS PS   |
| 4B       | --       | 3       | CT CLASS-5P10   |
| 4C       | --       | 3       | CT CLASS-1 (MIN. 10VA)  |
| 4D       | --       | 3       | CT FOR 87B CLASS PS   |
| 4E       | --       | 3       | CT FOR 87CH CLASS PS  |
| 5        | --       | 1       | HIGH SPEED MAKE PROOF EARTHING SWITCH   |
| 6        | --       | 1       | SURGE ARRESTOR  |
| 7        | --       | --      | DELETED   |
| 8        | 87       | 1       | DIRECTIONAL IDMTL O/C RELAY   |
|          | 51N      |         | IDMTL E/F RELAY (10-40%)  |
|          | 95-1/2   |         | TRIP CIRCUIT SUPERVISION RELAY  |
|          | 87N      |         | DIRECTIONAL IDMTL E/F RELAY   |
|          | 51V      |         | VOLTAGE RESTRAINED OVERCURRENT RELAY  |
|          | 51       |         | IDMTL O/C RELAY (50-200%)   |
| 9        | 86       | 1       | TRIPPING RELAY - CONVENTIONAL VAJH TYPE   |
| 10       | --       |         | DELETED   |
| 11       | --       | 6       | CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES   |
| 12       | --       | 1       | LOCAL/OFF/REMOTE SELECTOR SWITCH  |
| 13       | 52C/S    | 1       | BREAKER CONTROL SWITCH (TNC) (LOCKABLE WITH SPRING RETURN TO NEUTRAL) SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION            |
| 14       | --       | 1       | DELETED   |
| 15       | --       |         | DELETED   |
| 16       | --       | AS REQD | SF6 GAS MONITORING, ALARMS AND INDICATIONS  |
| 17       | --       | AS REQD | CLUSTER LED TYPE INDICATION LAMP  |
| 18       | --       | AS REQD | AUXILIARY RELAY   |
| R2 19    | 87F      | 2       | FEEDER DIFFERENTIAL PROTECTION RELAY  |
| 20       | --       | AS REQD | WINDOW ALARM ANNUNCIATIONS  |
| 21       | --       | 1       | LOAD MANAGER  |
| 22       | --       | 2 SET   | CUBICLE LAMP WITH MCB, DOOR SWITCH, PANEL SPACE HEATER & 3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP  |
| 23       | --       | 2       | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY FOR LCC & CRP   |
| 24       | --       | 2       | LV POWER SUPPLY SWITCH FUSE FOR LCC & CRP   |
| 25       | --       | 1       | AMMETER WITH 4 WAY A-S-S  |

**220KV GIS DATA SHEET**  
HARDWARE DATASHEET FOR OUTGOING PLANT FEEDER

|                                      |     |
|--------------------------------------|-----|
| DATA SHEET                           | REV |
| B269-999-16-50-DS-0041<br>Sht.1 OF 1 | B   |



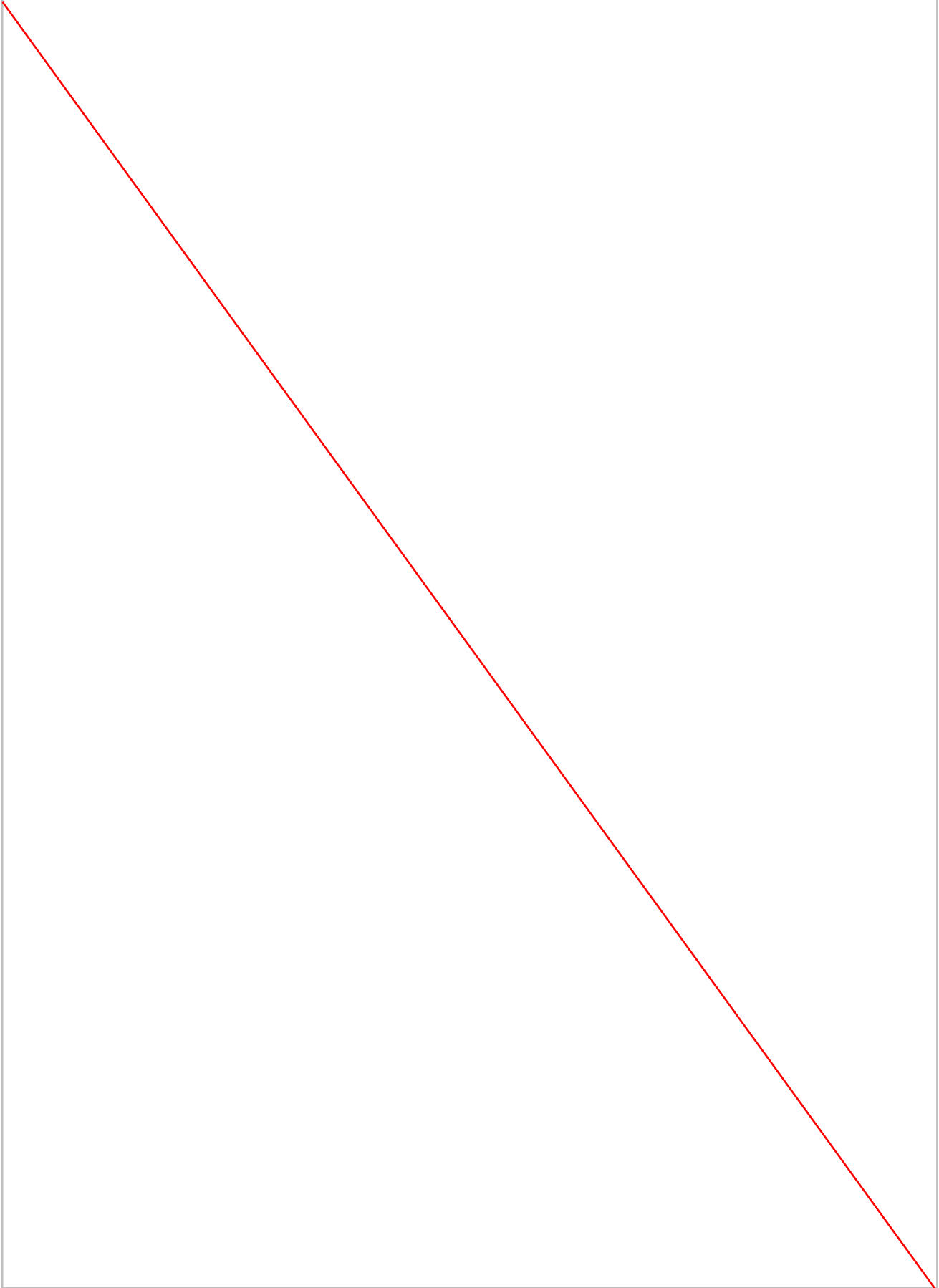
## 6.0 SPARE PARTS

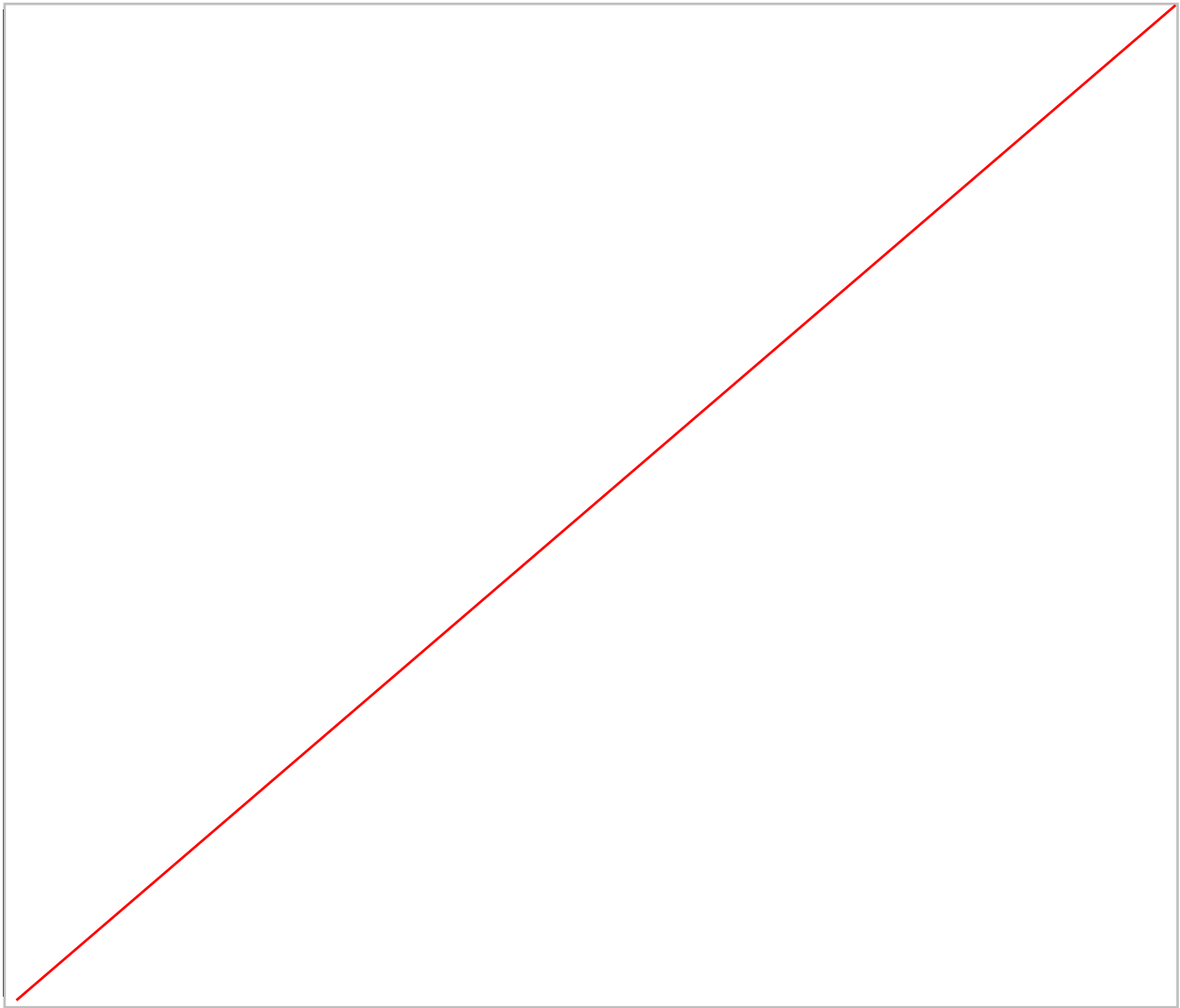
### 6.1 MANDATORY SPARES

Mandatory spares shall be procured along with the main equipment. Such spares for each equipment shall be as per the below table. These spares include only those spares, which are critical for equipment.

|                |  |                               |
|----------------|--|-------------------------------|
| 2              | EHV & HV Gas Insulated Switchboard (GIS)               |                               |
| <del>2.1</del> | <del>Portable gas filling equipment/SF6 gas cart</del> | <del>1 No.</del>              |
| 2.2            | Handle for disconnect switch drive                     | 4 Nos.                        |
| 2.3            | Handle for earthing switch drive                       | 4 Nos.                        |
| 2.4            | Pre selection key for three position switch            | 1 No.                         |
| 2.5            | Power cable termination kit                            | 2 sets                        |
| 2.6            | Tripping coil  | 1 No.                         |
| 2.7            | Closing coil   | 1 No.                         |
| 2.8            | Capacitive type voltage detectors                      | 1 Set                         |
| 2.9            | Control fuses / MCB                                    | 10 Nos. of each rating & type |
| 2.10           | Density monitoring device                              | 2 Nos of each type            |
| 2.11           | Pressure Gauge   | 2 Nos of each type            |
| 2.12           | Indicating lamps covers                                | 5 nos. of each colour         |

| S.No. | Part Description  | Description                             |
|-------|-------------------|---|
| 2.13  | Indicating lamps  | 20% or 3 nos. (min.), whichever is more |
| 2     | Power Transformer | one set of core for each transformer    |





**NOTES:**

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. Wherever % age is identified, Contractor shall supply next rounded figure.
3. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Mandatory spares as indicated above do not cover commissioning spares.
5. Mandatory spares as indicated above do not cover two year O&M spares.
6. Mandatory spares shall be applicable for electrical items of motors / sub-packages as per mandatory spares philosophy specified elsewhere in the bid document.
7. For Isolation breaker panel (GIS or AIS) one set of "Tripping Coil (1 No.), Closing coil (1 No.) and Control fuse/MCB (10 Nos. of each rating and type)" shall be considered as mandatory spares for each Isolation breaker panel (GIS or AIS).
8. For Isolation breaker panel (GIS or AIS) one set of "Auxiliary relays (1 no. of each type)" shall be considered as mandatory spares for Relays for Isolation breaker panel (GIS or AIS).

## **6.2 COMMISSIONING SPARES**

Commissioning Spare Parts shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended spares shall be obtained along with the offer.

## **6.3 RECOMMENDED SPARE FOR NORMAL OPERATION & MAINTAINENCE**

Quotation for two-years spares for normal operation and maintenance (over and above mandatory spares) along with unit price shall be obtained with the proposal for Client to order the same separately.

#### **6.4 SPECIAL TOOLS AND TACKLES**

Required Special Tools and Tackles shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended special tools/tackles shall be obtained along with the offer.

#### **7.0 VENDOR DATA REQUIREMENT**

Vendor Data Requirement as indicated in the respective equipment Material Requisitions shall be followed.

|      | Description  | UOM | QTY | Detailed Description of Scope  |
|------|--|-----|-----|--|
| 1.01 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - BUS BARS                             | LOT | 1   | <b>This covers complete GIS System as per technical specification excluding the following BOQ line items.</b>  |
| 1.02 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - TRANSFORMER GIS BAY MODULE (EXTN.)           | SET | 2   | <b>Extension by addition of transformer feeder bays in existing CG make 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear (one set each on both side). Feeder details similar to Sr. nos. 1 / 2 (Incomer from PR 220kV GIS with Line PT) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)</b>   |
| 1.03 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM -DOUBLE MAIN BUS SCHEME - GIS EXTENSION MODULE                  | SET | 2   | Bus extension module for interfacing of transformer feeder bays (of present scope) with existing CG make 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear (one set each on both side). Bidder shall consider the modules including the bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc as applicable.   |
| 1.04 | SUPPLY- GIS : 220KV, 50KA FOR 3S, OUTDOOR GIS ISOLATING BREAKER BAY  | SET | 2   | <b>Please refer Sr. nos. 1 / 2 (220kV GIS Outdoor IBP with Line PT) of the document: 220 kV ICG FEEDER DETAIL DATASHEET (HV-100101/HV-100102), Nos: B269-999-16-50-DS-0033. (Excluding SF6 to air bushing/ connection module &amp; Surge Arrester Module , Gas Insulated Bus Duct which are covered in separate BOQ item)</b>  |
| 1.05 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM-DOUBLE MAIN BUS SCHEME - SF6 TO AIR BUSHING/ CONNECTION         | SET | 6   | Single phase 220kV , 2000A SF6 to Air Bushing for the air termination of the GIS shall be as per IEC.<br>(a) Single phase, 400kV , 2000A , termination module for terminating GIS SF6 bus duct for Potheadyard.<br>(b) Scope of supply shall be as per latest version of IEC .<br>(c) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required.<br>(d) Barrier cones, mechanism box and other items as required.<br>(e) Any other item required to complete the system in all respects but not limited to above.  |
| 1.06 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - LINE GIS BAY                         | SET | 2   | <b>Incomer from Panipat Refinery 220kV GIS. Please refer Sr. nos. 1 / 2 (Incomer from PR 220kV GIS with Line PT) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)</b>   |
| 1.07 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - LINE GIS BAY (TYPE 2)                            | SET | 2   | <b>Incomer from Panipat Refinery Isolating Breaker Panel. Please refer Sr. nos. 3 / 4 (Incomer from PR IBP with Line PT) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)</b>   |
| 1.08 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - BUS COUPLER GIS BAY                              | SET | 2   | <b>Please refer Sr. nos. 5 / 6 (Bus Coupler 1A-2A &amp; Bus Coupler 1B-2B) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034</b>  |
| 1.09 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - BUS SECTIONALISER BAY MODULE                 | SET | 2   | <b>Please refer Sr. nos. 7 / 8 (Bus Coupler 1A-1B &amp; Bus Coupler 2A-2B) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034</b>  |
| 1.10 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - BUS MEASUREMENT GIS BAY/ VOLTAGE TRANSFORMER BAY | SET | 4   | <b>Please refer Sr. nos. 9 / 10 / 11 / 12 (Bus PT 1A, 1B, 2A &amp; 2B) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034</b>  |
| 1.11 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - TRANSFORMER GIS BAY                  | SET | 6   | <b>Please refer Sr. nos. 13 / 14 / 15 / 16 / 17 / 18 (Transformer Feeder) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)</b>  |
| 1.12 | SUPPLY- GIS : 220KV, 50KA FOR 3S, GIS DOUBLE MAIN BUS SCHEME - SPARE TRANSFORMER GIS BAY MODULE                    | SET | 2   | <b>Please refer Sr. nos. 19 / 20 (Transformer Feeder Spare) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)</b>  |
| 1.13 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM-DOUBLE MAIN BUS SCHEME - SF6 TO EHV CABLE GIS CONNECTION MODULE | SET | 12  | SF6 to EHV cable GIS connection module suitable upto 1600 Sqmm (above 630 Sqmm) and as per technical requirement mentioned in specification, 1 phase Cable, shall be as follows, but not limited to,<br>(a) It shall be of the plug-in type with dry-type or fluid-filled terminations. The interfaces conform to IEC standards. A removable link, which disconnects and isolates the GIS from the cable during high-voltage test for convenience and ease of operations shall also be provided.<br>(b) Termination kit for fixing of cable shall also be provided in line with IEC62271-209.<br>(c) PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, insulators etc. as required.<br>(d) Any other item required to complete the system in all respects but not limited to above. |

|      | Description  | UOM | QTY | Detailed Description of Scope  |
|------|--|-----|-----|--|
| 1.14 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - SF6 TO EHV CABLE GIS CONNECTION MODULE ( TYPE 2)   | No  | 36  | SF6 to EHV cable GIS connection module suitable upto 630 Sqmm and as per technical requirement mentioned in specification, 1 phase Cable, shall be as follows, but not limited to,<br>(a) It shall be of the plug-in type with dry-type or fluid-filled terminations. The interfaces conform to IEC standards. A removable link, which disconnects and isolates the GIS from the cable during high-voltage test for convenience and ease of operations shall also be provided.<br>(b) Termination kit for fixing of cable shall also be provided in line with IEC62271-209.<br>(c) PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, insulators etc. as required.<br>(d) Any other item required to complete the system in all respects but not limited to above.   |
| 1.15 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - GAS INSULATED BUS DUCT   | MTR | 30  | GIB length of 1-phase busduct outside the <u>GIS BAY MODULE</u> shall be considered for mode of measurement. This including SF6 Gas, structure, Earthing, foundation bolt, PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, compensator, insulators etc. Complete in all respect.  |
| 1.16 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - BUS EARTH SWITCH GIS BAY   | SET | 2   | 220kV, 50kA for 3 second, 2000A GIS double main bus scheme bus earth switch bay GIS bay, each set comprising of following but not limited to,<br>(a) 2 set- 1x3 phase high speed make proof grounding switch, complete with operating mechanism.<br>(b) PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, insulators etc. as required.<br>(c) Any other item required to complete the system in all respects but not limited to above.  |
| 1.17 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM-DOUBLE MAIN BUS SCHEME - GIS SURGE ARRESTER MODULE WITH SURGE COUNTER   | SET | 48  | 1 Set equals 1 Phase surge arrester. Necessary surge counter for every 3 numbers of surge arrester is inclusive in the scope.  |
| 1.18 | SUPPLY- GIS : 220KV, LOCAL CONTROL CUBICLE   | No  | 20  | Bidder shall meet the requirement of LCC for the complete GIS System, mode of measurement shall be nos. of Bays with Circuit Breaker. LCC requirements other than Circuit Breaker Bays i.e. Bus PT, Bus earthswitch etc shall be deemed inclusive of bidders scope of respective main item. 2 nos LCC Bay shall be outdoor type.   |
| 1.19 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION   | LOT | 1   | First filling of SF6 gas for the equipment supplied plus an additional quantity sufficient for conducting all the tests on equipment at site before placing it into successful operation <u>plus 10% extra</u> quantity of first filling as Quality of spare gas.  |
| 1.20 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM-DOUBLE MAIN BUS SCHEME - STRUCTURE MATERIALS FOR SUPPORT OF GIS, BUS DUCTS, SF6 TO OIL BUSHING/ CONNECTION AND SF6 TO AIR BUSHING/ CONNECTION INCLUDING FOUNDATION BOLTS, EMBEDDED ITEMS, RAILS AND/ OR OTHER ITEMS STRUCTURAL ITEMS REQUIRED | LOT | 1   | Structure Materials for support of GIS, SF6 to oil bushing/ connection and SF6 to air bushing/ connection including Foundation Bolts, Embedded Items, Rails and/ or other items structural items required. All steel structure members shall be hot-dip galvanized after fabrication. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels. In addition to above, supports, platforms, foundation bolts, embedded parts in floors etc., are also included in the scope as per the specification, but not limited to the following,<br>(a) Base Plate, Channel, Metallic / Structural Member for seating of GIS system<br>(b) Lattice / Pipe structure required for GIS bay, GIB,SF6 to oil bushing/ connection and SF6 to air bushing/ connection.<br>(c) Foundation bolt / Anchor Fastening bolts for GIS system, if required.<br>(d) Equipment fixing hardware.<br>(e) Cable tray arrangement (mounted on structures of) GIS bay, GIB,SF6 to oil bushing/ connection and SF6 to air bushing/ connection.<br>(f) Any other structural item required to complete the system in all respects but not limited to above. (Excluding structure for GIB which covered with main GIB item itself) |
| 1.21 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - EARTHING MATERIALS INCLUDING HIGH FREQUENCY EARTHING, IF APPLICABLE  | LOT | 1   | Earthing Materials, except 40mm MS rod,75x12mm / 50x6 GI Flat, which shall be provided by BHEL as free issue item (FIM), however, exact requirement shall be intimated by bidder based on the earthing philosophy approved, and Supervision of erection of all earthing connection for GIS to Earth Mesh on Floor shall be scope including any special requirements including high frequency earthing. In case, high frequency earthing is not required, necessary design and calculations shall be submitted by bidder.   |

|      | Description  | UOM | QTY | Detailed Description of Scope  |
|------|--|-----|-----|--|
| 1.22 | SUPPLY- GIS : 400KV, CONSUMABLES FOR GIS   | LOT | 1   | All consumables including grouting material and chemicals for the chemical anchors bolts etc., if applicable for GIS system shall be provided by bidder, however, in case of consumables with shelf life less than six months shall be supplied with special permission and intimation from BHEL.  |
| 2.01 | SUPPLY- GIS :ONLINE PARTIAL DISCHARGE (PD) MONITORING SYSTEM FOR BOTH INDOOR & OUTDOOR GIS   | LOT | 1   | 5.7.15.4 Online Partial Discharge(PD) monitoring system for (a) 220kV indoor GIS, (b) 220kV outdoor GIS & ('c) 220kV GIS extension. Please refer clause: 5.7.15.4 Online Partial Discharge(PD) monitoring system for both indoor & outdoor GIS of document: B269-999-16-50-SP-0020   |
| 2.02 | SUPPLY- GIS : ONLINE SF6 GAS FILLING / TOPPING-UP SYSTEM   | SET | 1   | Please refer clause:5.7.15.5 SF6 topping system of document: B269-999-16-50-SP-0020. SF6 topping system shall be provided for 220 kV GIS for filling / topping up SF6 gas to panel under energized condition manually.   |
| 2.03 | SUPPLY- GIS : PORTABLE PD ANALYZER/ MEASUREMENT KIT SUITABLE FOR GIS ALONG WITH REQUIRED ACCESSORIES                                     | SET | 1   |  |
| 2.04 | SUPPLY- GIS : SF6 GAS LEAKAGE DETECTOR   | SET | 1   | Please refer clause: 5.7.15.1 SF6 Gas leakage detector of document: B269-999-16-50-SP-0020   |
| 2.05 | SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS - SF6 GAS FILLING, EVACUATING, FILTERING, DRYING, PUMPING & STORAGE PLANT | SET | 1   | Please refer clause: 5.7.15.2 Gas filling and evacuating plant of document: B269-999-16-50-SP-0020   |
| 2.06 | SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS - SF6 GAS ANALYZER  | No  | 1   | Please refer clause: 5.7.15.3 SF6 gas analyser of document: B269-999-16-50-SP-0020   |
| 2.07 | SPARES- GIS : 220KV, MANDATORY SPARES AS PER TECHNICAL SPECIFICATION   | LOT | 1   | Price Break-up are to be submitted with technical bid  |
| 2.08 | SUPPLY- GIS : RECOMMENDED OPERATION AND MAINTENANCE SPARES   | LOT | 1   | Price Break-up are to be submitted with technical bid  |
| 3.01 | SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF GIS BAYS INCLUDING LCC   | LOT | 1   | Site service activities shall be carried out at in stages as per requirement or front availability at site, and hence multiple visits for completion of work are envisaged. Site visit for supervision of unloading & verification of materials for proper storage and up-keeping at site includes following activities but not limited to, (a) Supervision of safe unloading of GIS & its accessories at site. (b) Reconciliation, storage & up keeping of materials, with due instructions/ training to site persons for long storage. Supervision of complete GIS System (as per scope of supply) along with all bay Equipments, indoor & outdoor (excluding Bus duct and SF6 to air bushing covered separate BOQ line item) such as and not limited to GIS extension module, GIS bus extension module, surge arrester, voltage transformer, LCC including structure, cabling, earthing & other associated activities shall be included in the scope. (Excluding the Services item covered in separate BOQ items) |
| 3.02 | SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF GAS INSULATED BUS DUCT   | MTR | 30  | GIB length of 1-phase busduct outside the <u>GIS BAY MODULE</u> shall be considered for mode of measurement.   |
| 3.03 | SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF SF6 TO AIR BUSHING   | SET | 6   | Complete in all respect  |
| 3.04 | SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF GIS  | LOT | 1   | Complete in all respect (excluding Bus duct and SF6 to air bushing covered separate BOQ line item)   |
| 3.05 | SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF GAS INSULATED BUS DUCT   | MTR | 30  | Complete in all respect  |
| 3.06 | SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF SF6 TO AIR BUSHING   | SET | 6   | Complete in all respect  |
| 3.07 | SERVICES- GIS : 400KV, FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR        | LOT | 1   | Complete in all respect  |
| 3.08 | SERVICES- GIS : INSULATION CO-ORDINATION STUDIES FOR GIS SYSTEM  | LOT | 1   | Complete in all respect  |

| Sno    | TITLE   | UOM | QTY       | Remark   |
|--------|---|-----|-----------|--|
| 1.0100 | Supply: Unit reference price of GIS part item/ equipment  |     |           | GIS part item/ equipment shall be required for supply as a mandatory spares or any addition/ deletion of equipment, due to damage, theft, additional requirement by customer during detailed engineering or later stage. It is to be ensured by bidder that unit prices have a logical relationship with prices of assemblies in main items (Bay, Busbar etc). The reference prices shall be used for <b>breakup rates, if required at any stage. The reference prices shall be considered</b> |
| 1.0101 | Supply: Unit reference price of GIS part item/ equipment- 220kV 2000A Circuit Breaker   | Set | 1         | 1 Set= 1 No of single pole with enclosure & without operating mechanism  |
| 1.0102 | Supply: Unit reference price of GIS part item/ equipment- 220kV 1250A Circuit Breaker   | Set | 1         | 1 Set= 1 No of single pole with enclosure & without operating mechanism  |
| 1.0103 | Supply: Unit reference price of GIS part item/ equipment- 220kV 2000A Disconnecter with Maintenance Earthing Switch   | Set | 1         | 1 Set= 1 No of three pole with enclosure & without operating mechanism   |
| 1.0104 | Supply: Unit reference price of GIS part item/ equipment- 220kV 2000A Disconnecter without Maintenance Earthing Switch  | Set | 1         | 1 Set= 1 No of three pole with enclosure & without operating mechanism   |
| 1.0105 | Supply: Unit reference price of GIS part item/ equipment- 220kV 2000A Fast acting make proof grounding switch/ High speed make proof grounding switch             | Set | 1         | 1 Set= 1 No of three pole with enclosure & without operating mechanism   |
| 1.0106 | Supply: Unit reference price of GIS part item/ equipment- Surge Arrestor including Surge Counter  | Set | 1         | 1 Set= 1 No of single pole with enclosure  |
| 1.0107 | Supply: Unit reference price of GIS part item/ equipment- Surge Counter   | Set | 1         | 1 Set= 1 No  |
| 1.0108 | Supply: Unit reference price of GIS part item/ equipment- 220kV Current Transformer for Line Bay  | Set | 1         | 1 Set= 4 core of 1 phase CT with enclosure, payable on prorata basis   |
| 1.0109 | Supply: Unit reference price of GIS part item/ equipment- 220kV Current Transformer for Transformer Bay   | Set | 1         | 1 Set= 5 core of 1 phase CT with enclosure, payable on prorata basis   |
| 1.0110 | Supply: Unit reference price of GIS part item/ equipment- 220kV Voltage Transformer   | Set | 1         | 1 Set= 3 core of 1 phase PT with enclosure, payable on prorata basis   |
| 1.0111 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism for Circuit Breaker   | Set | 1         | 1 Set= 1 No operating Mechanism suitable for 3 Phase CB  |
| 1.0112 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism for Disconnecter with Maintenance earthing switch                                   | Set | 1         | 1 Set= 1 No operating Mechanism suitable for 3 Phase Disconnecter with Maintenance earthing switch   |
| 1.0113 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism box for Disconnecter without Maintenance earthing switch                            | Set | 1         | 1 Set= 1 No operating Mechanism suitable for 3 Phase Disconnecter without Maintenance earthing switch  |
| 1.0114 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism box for Disconnecter with Maintenance earthing switch                               | Set | 1         | 1 Set= 1 No operating Mechanism box suitable for 3 Phase Disconnecter with Maintenance earthing switch   |
| 1.0115 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism box for Disconnecter without Maintenance earthing switch                            | Set | 1         | 1 Set= 1 No operating Mechanism box suitable for 3 Phase Disconnecter without Maintenance earthing switch  |
| 1.0116 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism for Fast acting make proof grounding switch/ High speed make proof grounding switch | Set | 1         | 1 Set= 1 No operating Mechanism suitable for 3 Phase Fast acting make proof grounding switch/ High speed   |
| 1.0117 | Supply: Unit reference price of GIS part item/ equipment- 220kV, 1 Phase bus bar conductor  | Kg  | 50        | any rating and type  |
| 1.0118 | Supply: Unit reference price of GIS part item/ equipment- 220kV, 1 phase GIS metallic enclosure for bus bar/ any equipment  | Kg  | 100       | any rating and type  |
| 1.0119 | Supply: Unit reference price of GIS part item/ equipment- Gas permeable/ communication/ barrier type Insulator  | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0120 | Supply: Unit reference price of GIS part item/ equipment- Gas non-permeable/ non - communication/ non-barrier type Insulator                                      | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0121 | Supply: Unit reference price of GIS part item/ equipment- PD sensor   | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0122 | Supply: Unit reference price of GIS part item/ equipment- Pressure/ density monitor monitor device & Switch   | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0123 | Supply: Unit reference price of GIS part item/ equipment- Pressure relief device  | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0124 | Supply: Unit reference price of GIS part item/ equipment- Rupture disc  | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0125 | Supply: Unit reference price of GIS part item/ equipment- Expansion   | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0126 | Supply: Unit reference price of GIS part item/ equipment- Flexible connections  | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0127 | Supply: Unit reference price of GIS part item/ equipment- Gas seals   | KG  | 2         | Any type as per requirements   |
| 1.0128 | SPARES- GIS : 220KV, TEE BEND   | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0129 | SPARES- GIS : 220KV, ANGLE BEND (135°)  | Set | 1         | 1 Set= 1 No of any rating and type for single phase (if applicable in design)  |
| 1.0130 | SPARES- GIS : 220KV, L-BEND   | Set | 1         | 1 Set= 1 No of any rating and type for single phase  |
| 1.0131 | SERVICES- GIS : 220KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR SUPERVISION OF ERECTION OF GIS  | 10  | MANDATORY | Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by  |
| 1.0132 | SERVICES- GIS : 220KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR TESTING & COMMISSIONING OF GIS  | 10  | MANDATORY | Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by  |
| 1.0133 | SERVICES- GIS : 220KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - HIRING CHARGES OF HV TEST KIT WITH OPERATOR  | 1   | LOT       | Additional HV test kit charges including charges of operator, HV test kit, accessories & tools required for completion of HV test (Dielectric Test after installation of GIS). This item is executed only if repetition/ additional HV Test is required by BHEL i.e. post successful commissioning of GIS. (if required due to reasons not attributed to the contractor)   |

## SECTION-2

**Bidder to please read this documents for scope of supply & services for 220kV GIS and associated equipment, system etc. Other portion of document please be ignored.**

# SCOPE OF WORK & JOB SPECIFICATION (ELECTRICAL) FOR 220kV GIS PACKAGE (TENDER NO. B269-999-16-50-EB-T-0020)

**PROJECT :** P25 PROJECT  
**OWNER :** M/s INDIAN OIL CORPORATION LTD.  
**EPMC :** ENGINEERS INDIA LTD.  
**JOB NO. :** B269

| C       | 27.09.2021 | REVISED AND REISSUED WITH TENDER | AKG         | HK         | HK          |
|---------|------------|----------------------------------|-------------|------------|-------------|
| B       | 05.07.2021 | REVISED AND REISSUED WITH TENDER | AKG         | HK         | HK          |
| A       | 12.05.2020 | ISSUED WITH TENDER               | AKG         | HK         | HK          |
| Rev. No | Date       | Purpose                          | Prepared by | Checked by | Approved by |

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## 1 GENERAL

### 1.1 INTRODUCTION

1.1.1 This section defines the electrical scope of work and job specification for 220 kV Gas Insulated Substation Package for P25 Project of IOCL – Panipat Refinery. This specification along with design basis, design philosophy, equipment datasheets, equipment specifications, drawings/ documents and other codes/ standards attached or referred shall form the basis for detailed design and engineering, manufacturing, supply, erection, testing, pre-commissioning, commissioning of the electrics covered in this tender of 220 kV Gas Insulated Substation Package for P25 Project of IOCL – Panipat Refinery.

1.1.2 The work shall be carried out to the best workmanship, in conformity with the specifications, approved drawings/ construction drawings and the instructions of the owner or Engineer-in-Charge from time to time.

1.1.3 The contract shall include clearing of temporary constructions, waste materials and loose earth, which might get collected in and nearby the work site during execution of work and after final completion.

### 1.2 STANDARDS

1.2.1 The work / equipment shall also comply with the requirements of latest revision of codes & standards attached or referred with the tender document. In case of any conflict between the various documents, the most stringent one shall be followed and Owner's/ EIL decision in this regard shall be final and binding. It is the responsibility of the Contractor to highlight any contradictions between various documents at the bid stage itself.

1.2.2 In case of imported equipment, codes and standards of the country of origin may be followed, if these standards are equivalent or stringent than the applicable Indian standards and meet the statutory regulations of approving Indian statutory bodies.

1.2.3 In addition, the work shall also conform to the requirements of latest editions/ amendments of the following:

- The CEA guidelines and rules framed there under.
- The fire insurance Regulations.
- Indian Petroleum Rules.
- The regulations laid down by Electrical Inspectorate (CEA).
- The regulations laid down by the Factory Inspectorate
- The regulations laid down by the Chief Controller of Explosives.
- The regulations laid down by Oil Industries Safety Directorate (OISD).
- Any other regulations laid down by the Central, State or Local Authorities from time to time during the execution of this contract.

### 1.3 GUARANTEE

1.3.1 The contractor shall guarantee the installation for satisfactory operation against any defects of workmanship and materials (supplied by the contractor) for a period as specified elsewhere. Any damage or defect connected with the erection of materials, equipments or fittings supplied by the contractor that may be discovered at the time of issue of the completion certificate, or arise or come to light thereafter, shall be rectified or replaced by the contractor at his own expense as deemed necessary and as per the instruction of Owner or Engineer-in-Charge within the time limit specified by the Owner or Engineer-in-Charge.

1.3.2 The above guarantee shall be applicable for the quality of the work executed as well as for all equipment/ cables/ fixtures/ fittings/ other materials supplied by the contractor.

### 1.4 SITE CONDITION

For site conditions refer the clause 5.1 of Electrical Design Basis document B269-999-16-50-EDB-1001 enclosed with the package.

## 1.5 UTILIZATION VOLTAGE

For details of the utilization voltage refer the electrical design basis document B269-999-16-50-EDB-1001 enclosed with the package.

For the works to be executed in existing refinery area, utilisation voltage for control supplies i.e. 110V / 220V DC OR 110V AC UPS, shall be finalised during detailed engineering.

## 1.6 ENGINEERING AND JOB SPECIFIC REQUIREMENTS

- 1.6.1** Various equipment (to be supplied by contractor) covered in this tender, shall be in compliance with the requirements defined in design philosophy, equipment datasheets and specifications attached/ referred. Besides these, the requirements as defined in respective clauses for individual equipment, referred elsewhere in this document shall also be considered/ complied with.
- 1.6.2** Contractor shall ensure that all electrical equipment shall comply with the site and system conditions, ratings and other technical requirement specified elsewhere with the documents attached with the tender.
- 1.6.3** CONTRACTOR shall use this specification, datasheet, design philosophy document and OWNER/ Consultant's standard specifications for various equipments. For equipments, where OWNER/Consultant standard specifications are not available, have not been attached, CONTRACTOR/ SUPPLIER shall use their own specification, developed based on project specific requirement and good engineering practices prevalent in petroleum industry, so as to ensure satisfactory operation and maintenance conditions. CONTRACTOR to however check from OWNER/ EIL with respect to availability of EIL standard/ specification, before use of their own specification
- 1.6.4** CONTRACTOR shall note that data sheets for some of the equipment are not enclosed separately. Equipment data sheets for such equipments shall be prepared by the CONTRACTOR/ SUPPLIER based on relevant codes and specifications and the data sheet shall contain all technical data and information which is essential for the purpose of review and technical acceptability, detailed engineering, installation, testing, repair and maintenance, replacement, etc. of the equipments. CONTRACTOR to however check from OWNER/ EIL with respect to availability of standard datasheet, before use of their own datasheet
- 1.6.5** The CONTRACTOR shall also prepare data sheets mentioned in OWNER/ Consultant standard specifications, but not enclosed with the package.
- 1.6.6** The equipment shall in general conform to latest revision of statutory regulations, Indian Standards, IEC/ Other international standards applicable for the country of origin of the equipment
- 1.6.7** All equipment shall be subjected to routine and acceptance tests as per applicable specifications.
- 1.6.8** CONTRACTOR shall clearly specify in their purchase specifications, the requirement of conducting other special tests/ type tests, envisaged for various electrical equipment. Same shall be conducted without any time/ cost implication to OWNER/ Consultant.

## 2 POWER SYSTEM DESCRIPTION

To meet the power requirement of P25 Project in IOCL Panipat Refinery, power will be received at 220kV from two sources.

First source shall be from the 220kV GIS in existing Panipat Refinery, which will provided two nos. plant feeders with single core copper cables. These plant feeders will be connected to the 220kV GIS for P25 Project.

Second source of power shall be from state electricity board through double circuit overhead line at 220kV. These lines shall be terminated on the outdoor gantry located in existing refinery area along with outdoor type 220kV GIS bays and further connection will be made to the 220kV GIS for P25 Project though single core copper cables.

Once this power is received at the 220kV GIS, same shall be then stepped down to 66kV using 220/66kV power transformers. These power transformers in turn will be connected to 66kV GIS.

Primary distribution in the plant shall be done at 66kV using the 66kV GIS located in Main Receiving Substation (MRSS). 66kV transformer feeders from MRSS, each rated for 100% load, will supply power to downstream substation. Power will be received at 66/6.9kV power transformers (located outdoor) via 66 kV (Earthed grade) cables. The step down power at 6.6 kV shall be fed to 6.6 kV switchboard having two incomers & two bus sections interconnected by means of a bus coupler set (one normal buscoupler & one dummy buscoupler) and having fast bus transfer system. This 6.6kV board shall cater to all 6.6 kV loads. All HV motors rated above 160kW shall be at 6.6 kV fed from 6.6 kV switchboard. Power shall be stepped down to 415 V using 6.6 kV / 0.433 kV distribution transformers for feeding 415V loads through power control centers, motor control centers and Auxiliary service boards.

MV motors up to 55 kW will be fed from MCC whereas, motors rated above 55 kW and up to 160 kW will be fed from PCC. Auto/Manual changeover facility shall be provided in PCC & MCC while mechanical interlock shall be provided in incomers for ASB/LDB.

Auxiliary service board (ASB) shall have two incomers, one from normal PCC and other from emergency PCC. Normally bus coupler in auxiliary switchboard shall remain closed while incomer from emergency PCC shall remain open. During normal supply failure, buscoupler and normal supply incomer shall be opened. Auxiliary service board shall feed miscellaneous loads like welding receptacles, power panels etc.

220kV, 66 kV and 415 V systems are solidly earthed, whereas, 6.6 kV system is resistance earthed.

A separate EPMC has been envisaged for feeding plant emergency loads. EPMC will be fed via 1 no. 6.6/0.433 kV distribution transformer and through DG to provide reliability in the system.

EPMC will have two sections interconnected by a normally open buscoupler. EPMC shall be provided with auto transfer facility.

Plant normal lighting loads will be fed through normal lighting distribution board having two incoming supplies fed through 415V/415V lighting transformers fed from each bus section of normal PCC.

25% of plant lighting will be on emergency. Emergency lighting load will be fed through an emergency lighting distribution board having both incoming supplies fed through 415V/415V lighting transformers from each bus section of emergency PMCC.

230V AC UPS shall be provided in the substation for feeding control supply for ECS Panels, LAN, HMIs, etc., in substation.

220V DC battery and chargers shall be provided to feed critical DC lighting, and 110V DC system for switchgear protection and control circuits which will be located in the substation building.

ECS system shall be procured by Owner. All equipments shall be connected to ECS for monitoring and control as per ECS IO list.

Refer key single line diagram and scope demarcation drawing for typical power distribution scheme and broad scope demarcation.

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#### 4.5 SINGLE LINE DIAGRAM

It is the responsibility of the contractor to provide number of outgoing feeders in each switchboard as per actual loads, other electrical system requirements plus spare feeders in each switchboard in line with engineering design basis.

Contractor shall prepare Single line diagram for complete package and submit the same to Owner/ Consultant for approval. Equipments as required, as per the bid package to cater the load demand of package and owner's load shall be supplied without any price and time impact to Owner/ Consultant.

### 5 EQUIPMENT SPECIFICATIONS

#### 5.1 POWER TRANSFORMER

5.1.1 Tag Number for various transformers is as per table below

| Tag Number | Rating   | Impedance                              | Cable Termination   |   |
|------------|--|--|---|---|
| TR-100013  | 220/66 kV,<br>100/125 MVA,<br>ONAN/ ONAF,<br>YNyn0,<br>OLTC $\pm 10\%$ (In<br>step of $\pm 1.25\%$ ) | Z = 12.5% with<br>$\pm 10\%$ tolerance | <b>At 220 kV Side</b><br>245 kV (E),<br>1 Run/ phase,                                     | <b>At 66 kV Side</b><br>Gas Insulated<br>single phase<br>busduct      |
| TR-100014  |  |  | 1C x 400 Sq.mm,<br>Cu Conductor,<br>XLPE Insulated,<br>Armoured,<br>Corrugated            |   |
| TR-100015  |  |  | Aluminium, PVC<br>Outer sheath  |   |
| TR-100016  |  |  | Cable   |   |
| TR-100011  | 220/66 kV,<br>40/50 MVA,<br>ONAN/ ONAF,<br>YNyn0,<br>OLTC $\pm 10\%$ (In<br>step of $\pm 1.25\%$ )   | Z = 12.5% with<br>$\pm 10\%$ tolerance | <b>At 220 kV Side</b><br>245 kV (E),<br>1 Run/ phase,                                     | <b>At 66 kV Side</b><br>Gas Insulated<br>single phase<br>busduct      |
| TR-100012  |  |  | 1C x 400 Sq.mm,<br>Cu Conductor,<br>XLPE Insulated,<br>Armoured,<br>Corrugated            |   |
| TR-100001  | 220/33 kV,<br>60/75 MVA,<br>ONAN/ ONAF,<br>YNyn0,  | Z = 12.5% with<br>$\pm 10\%$ tolerance | <b>At 220 kV Side</b><br>245 kV (E),<br>1 Run/ phase,<br>1C x 400 Sq.mm,<br>Cu Conductor, | <b>At 33kV Side</b><br>33kV (E),<br>6 Run/ phase,<br>3C x 300 Sq.mm., |

- 5.3.10** All control cabinets, junction boxes etc. located in outdoor switchyard area shall have enclosure protection of IP55 (minimum) and shall be provided with additional GI canopy.
- 5.3.11** The drawings enclosed are for contractor's guidance in understanding the scope and type of work and shall form an integral part of the specification. However, it is the responsibility of the contractor to provide safe and reliable system meeting all the requirements stipulated in standards and guidelines issued by electricity boards and Chief Electrical Inspector.
- 5.3.12** For various equipments of the outdoor switchyard refer to the respective datasheets attached with the tender.
- 5.3.13** All around peripheral road of 7m width along with clearance of approx. 9m from road center to gantry support tower center shall be ensured while preparing the switchyard layout.
- 5.3.14** Separate metering room in outdoor switchyard of minimum size 3x4m shall be provided for HVPNL. Final dimension of same shall be as per HVPNL requirement.
- 5.3.15** Tri vector meter to be provided shall have function to measure MWH, MVAH, MVARH, MD, as a minimum. Additional functional & specification requirements and accuracy class shall be as per HVPNL requirements. Approval for make & mode of tri vector meter shall be obtained from HVPNL before placement of order.
- 5.3.16** For Open Access metering purpose, at least one separate dedicated core in the metering CTs in the Incoming line bays to be kept of 0.2S class and One Core of Line VT to be kept of 0.2 class for open access metering. The VA shall have to be selected based on the net burden ensuring 90% loading of CTs and PTs for open access metering purposes. The VA rating shall be decided during detailed engineering stage.
- 5.3.17** Burden of CTs, PTs & CVTs shall be meet the technical specification for respective equipments as issued by HVPNL.
- 5.3.18** Suitable interlocking shall be provided between various Isolators / Circuit Breakers / Earth Switches during close/open operations as per protection philosophy guidelines of HVPNL.
- 5.3.19** Contractor to ensure that valid type test certificates as per IS/ IEC and ITP attached is available with manufacturer for offered design of outdoor switchyard equipment. In case of non-availability of type test certificates same shall be conducted without any cost and time implication to Owner/ EIL.
- 5.3.20** PLCC system with wave traps & 48V DC System for both end shall be procured as part of the new switchyard tender and sending end equipments shall be free issued to HVPNL end contractor. Installation, testing commissioning at the sending end shall be taken care by others.
- 5.3.21** OPGW system including all control panels and other equipment at sending end at HVPNL switchyard shall be taken care of by others.
- 5.3.22** While preparing the layout & procuring equipment for installation in outdoor switchyard, CONTRACTOR to ensure that HVPNL specification are complied with as same shall be required to be mandatorily followed for statutory approval from HVPNL.

bimetallic washer/plates shall be provided.

## **5.6 GENERAL REQUIREMENT FOR ALL EHV, HV & MV SWITCHGEAR**

- 5.6.1** Selection, sizing and suitability of all components shall be the CONTRACTOR's responsibility. The equipment as required for safe and satisfactory operation shall be considered included in CONTRACTOR's scope even if not specifically mentioned.
- 5.6.2** Hardware data sheet for feeders include only the major relays, meters and control switches. Any auxiliary relays, timers, switches, etc., as required, while developing the control schematics and for safe operation, even if these are not specifically mentioned, shall be supplied by the CONTRACTOR without any price and time implication. All logic shall be

implemented in the relay itself and not externally. Provision of adequate I/O count in the relays shall be ensured.

- 5.6.3** The CONTRACTOR's shall be solely responsible to coordinate the relay characteristics with relay supplier for the proper selection of all CTs with special care to select class PS CTs. The VA burden, knee-point voltage, CT resistance and magnetizing current shall be calculated by the vendor for Owner/ EIL's review before proceeding with manufacturing.
- 5.6.4** Following sizing calculation for Class PS CT's shall be submitted by CONTRACTOR's during drawing review stage.
- Knee point voltage  $V_k$
  - Metrosil
  - Stabilizing resistor.
- 5.6.5** CT ratios/ details, load details, cable sizes, feeder nos., name plate details etc., for all feeders at switchboards shall be finalized at the time of review of vendor drawings which shall be taken care by the CONTRACTOR without any impact on cost and time to Owner.
- 5.6.6** The size of bus-bar from horizontal bus to breaker and breaker to outgoing shall be designed based on breaker rating and not on CT/feeder rating.
- 5.6.8** Dummy panels and rear extensions, as required, to avoid fouling with beam/ column, adequacy of space for cable terminations, bus trunking, mounting of relays, meters, control components etc. shall be supplied as required without time & cost implication to owner.
- 5.6.9** Breaker rating as specified in the data sheet is 'in-panel' rating at design ambient. CONTRACTOR may select higher rating of breaker if there is de-rating factor for 'in-panel' rating and due to design ambient. No force cooling shall be accepted
- 5.6.10** Breaker control switches shall be hardwired type. All TNC and Trip Switch shall be lockable type.
- 5.6.11** Spring charging motors shall be suitable for 110V DC supply.
- 5.6.12** All feeders/switchboards shall have provision for LOTO implementation. Photographs of LOTO provision in each type of panels shall be submitted during drawing review for approval.
- 5.6.13** All transformer incipient faults signals shall be wired through interposing contactors in the panel to avoid nuisance tripping.
- 5.6.14** 4-Pole MCB shall be considered in all the PT panels. 4th pole contact of the MCB shall be used for blocking under voltage protection function. Bi-stable relays shall be considered in PT panels for multiplication of the contact for under voltage blocking function in each feeder.

- 5.6.15** In Control logics / schemes, contacts of vacuum/ SF6 circuit breaker shall be utilized. In case, same is not available, then Bi-stable relays shall be considered for multiplication of Circuit breaker contacts.
- 5.6.16** Wherever failsafe contact concept is used, it shall use mechanical contacts. In case mechanical contacts cannot be provided, failsafe concept shall not be used.
- 5.6.17** The details of all Instrument transformers comprising their full name plate and connection diagram shall be displayed with stickers at an easily accessible location (In addition to Instrument transformer itself), during normal operation.
- 5.6.18** All the CT & PT connection should be through ring type reliable connection/terminations only.
- 5.6.19** Terminal connectors of all other control terminals shall be screwed type only. Separate terminal block shall be provided for further wiring to ECS/ upstream breaker/ Transformer, etc. for tripping/ interlock/ annunciation, etc.
- 5.6.20** All the NO, NC contacts of breaker, Relay DI/DO, RTD inputs, etc. shall be wired upto terminal block, even if the contacts are not used in the scheme.
- 5.6.21** Terminal multiplication to be done, wherever double control cable termination is done, i.e. only one control cable wire shall be connected to one terminal.
- 5.6.22** Additional 2 set of spare CT and PT terminals shall be provided for tapping CT and PT supply for future purpose in Incomers/ bus couplers/ Line PT and Bus PT of all switchboards.
- 5.6.23** It is required to interface EHV, HV and MV switchgears with the ECS Panel for control, monitoring and annunciation purpose. For ECS Interface, typical ECS IO list is attached.
- 5.6.24** In addition to above, terminals as required for interface with upstream and downstream switchgear needs to be provided to fulfil the operational requirements.
- 5.6.25** Hardware, as required, including selector switches, auxiliary relays, etc. during detail engineering to meet the operation requirement shall be supplied by vendor without any time and cost implication.
- 5.6.26** Vendor to note that the control cables used shall be 2.5 sq. mm. twisted pair shielded cables.
- 5.6.27** All signals as per ECS IO List shall be provided for interface with the Electrical control system.
- 5.6.28** Terminals for DCS & ECS, input & output shall be segregated & separate terminal block shall be provided. While wiring these signals from respective feeder module to marshalling, it shall be ensured that separate cables are used for status & commands & same shall be segregated.
- 5.6.29** Current rating for interface contacts shall be 2A, 220V DC or 240V AC.
- 5.6.30** For the DC Control supply to the various breaker panels in EHV GIS, HV IBPS & 415V Switchboards, there shall be one common control switch for all control supply to the panel. Separate fuses for following branch circuit shall be provided:
- 5.6.30.1 Spring charging circuit
- 5.6.30.2 Closing circuit
- 5.6.30.3 Tripping, contact multiplier & digital input circuit
- 5.6.30.4 Indication circuit
- 5.6.30.5 Each Numerical relay supply (incoming of numerical relay supply fuse shall be tapped before the control supply switch)
- 5.6.31** Separate control supply switch shall be provided for differential protection relays.
- 5.6.32** Bus differential scheme shall have dedicated supply from the same bus section.
- 5.6.33** CT Bypassing relay shall be latched type.

- 5.6.34** Bus differential multiplier relay shall be VAJH type only.
- 5.6.35** Common lock key shall be provided for breakers in place of individual lock key for each breaker.

**5.7 220 kV & 66kV GAS INSULATED SWITCHGEAR**

- 5.7.1** 220 kV, 2000 Amps, 50 kA (3 Sec) Double Bus Bar GIS Panel & 66kV, 3150A, 40kA (3 Sec) Double Bus Bar GIS Panel shall be as per EIL standard specification 6-51-0066, complete with metering and protection as per datasheet attached with tender. LCC and separate CRP shall be supplied for each bay. Tag number of various equipments shall be as follows:

| Tag Number | Item   |
|------------|--|
| HV-100101  | Outdoor 220kV GIS Isolating Breaker Panel                  |
| LCC-100101 | Outdoor LCC of 220 kV GIS Isolating Breaker Panel          |
| CRP-100101 | Control & Relay Panel of 220kV GIS Isolating Breaker Panel |
| HV-100102  | Outdoor 220kV GIS Isolating Breaker Panel                  |
| LCC-100102 | Outdoor LCC of 220 kV GIS Isolating Breaker Panel          |
| CRP-100102 | Control & Relay Panel of 220kV GIS Isolating Breaker Panel |
| HV-100103  | 220kV GIS Switchgear                                       |
| LCC-100103 | LCC of 220kV GIS Switchgear                                |
| CRP-100103 | Control & Relay Panel of 220kV GIS Switchgear              |
| HV-100111  | 66kV GIS Switchgear  |
| LCC-100111 | LCC of 66kV GIS Switchgear                                 |
| CRP-100111 | Control & Relay Panel of 66kV GIS Switchgear               |

- 5.7.2** The equipment shall be designed for operation in applicable seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. To prevent the movement of GIS sub-assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to Owner's/ EIL approval.
- 5.7.3** For feeder details and power cable termination kits, refer SLD & feeder detail datasheets attached with tender. Sequence/position of various feeder as shown in the SLD is indicative and same shall be finalised during detailed engineering without any cost and time implication to Owner/EIL.
- 5.7.4** The offered GIS equipment and components shall conform to the type tests as per IEC 62271-203. CONTRACTOR to ensure at the time of order placement that copies of valid type test certificates for tests conducted on identical design of offered equipment is available. In case of non-availability of type test certificates, same shall be conducted without any cost and time implication to Owner/ EIL.

**5.7.5** GIS shall be designed in such a way that transfer from one bus isolator to another bus isolator shall be possible in energised condition without any break in supply to the loads.

**5.7.9** In addition to the requirements specified in 6-51-0066, following clauses shall also be complied.

5.7.9.1 The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF<sub>6</sub> gas & separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limits the effects of gas leaks failure and internal arcs, etc. These compartments shall be such that maintenance, repair, extension on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

5.7.9.2 The switchgear shall be of modular design and shall have complete phase segregation for the active components (i.e. Isolators, breakers, earth switch, etc.). The conductors and the live parts shall be mounted on high grade epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage recommended by IEC. These shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF<sub>6</sub> breakdown under arcing conditions.

5.7.9.3 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced during maintenance, this compartment shall be designed so that it shall remain in service to perform its intended duty. The gas tight barriers shall be clearly marked on the outside of the enclosures.

5.7.9.4 The bus enclosure should be sectionalized in a manner that maintenance, repair or extension work on any bus disconnecter (when bus and bus disconnecter are enclosed in a single/ three phase enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus. The design of 220 kV GIS shall be such that in

case a circuit breaker/ any other module of a feeder is removed for maintenance, both bus bars shall remain in service. For achieving the above requirements, adequate mechanical support and number of intermediate gas tight compartments as required, shall be provided to ensure equipment and operating personnel's safety.

- 5.7.9.5 The material and thickness of the enclosures shall be such as to withstand an internal flash over for a period of 300 mill second at rated short time withstand current.
- 5.7.9.6 Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes to which it is subjected in service (ASME/ CENELEC code for pressure vessel) and based on the design temperature and design pressures as defined in IEC-62271-203.
- 5.7.9.7 The bursting strength of Aluminium castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure. Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.
- 5.7.9.8 The thermal rating of all current carrying parts shall be minimum for three second for the rated symmetrical short-circuit current.
- 5.7.9.9 The ladders and walkways shall be provided wherever necessary for access to the equipment. The enclosure and support structure shall be designed that a person of 1780 mm in height and 80 kg in weight is able to climb on the equipment for maintenance.
- 5.7.9.10 In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness when the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.
- 5.7.9.11 The GIS shall be designed, so as to take care of the Very Fast Transients (VFT) over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage of the equipment. Necessary measures shall be under taken by GIS manufacturer to restrict maximum VFT over voltages lower than the lightning impulse withstand voltage. Manufacturer shall submit the study report of VFTO generated for GIS installation.
- 5.7.9.12 The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, Year- 2000. The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.
- 5.7.9.13 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro –Tesla on the surface of the enclosure. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.
- 5.7.9.14 Alarm circuit shall not respond to faults for momentary conditions. The following indications including those specified elsewhere in the specifications shall be provided in the alarm and indication circuits.

### Gas Insulating System

- Loss of Gas Density.
- Loss of Heater power (if required)
- Any other alarm necessary to indicate deterioration of the gas insulating system.

### Operating System

- Low operating pressure.
- Loss of Heater power.
- Loss of operating power.
- Loss of control supply.
- Pole Discordance

5.7.9.15 Metallic bellows for permitting the movement during expansion and contraction may be of following types:

- Lateral / Vertical mounting units
- Axial compensators
- Parallel compensators
- Tolerance compensators
- Vibration compensators

5.7.9.16 The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase to earth fault and discharges between contacts during switching operation. The earthing system shall ensure safe touch & step voltages in all the enclosures.

5.7.9.17 In order to ensure the security of personnel, equipotential earth mat shall be provided, where the enclosures and fixed accessories are accessible for the floor and manual operation of apparatus or locking system is located.

5.7.9.18 Contractor shall provide adequate number of UHF sensors in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270 through Partial Discharge (PD) monitoring system and the number and location of these sensors shall be subject to approval of Owner/ EIL. Further UHF sensors shall necessarily be provided in close proximity to VT compartments.

However adequacy of number of sensors and their location shall be verified at site by the contractor as per recommendations of CIGRE task force TF 15/33.03.05 (**Task force on Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the acoustic method**). In case during site testing additional UHF sensors are required, the same shall also be supplied & installed to complete the technical requirement without cost and time implication to purchaser.

5.7.9.19 The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. Contractor shall make available during detailed engineering stage, the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor connection arrangement, bolt spacing & dimension, rated gas pressure, etc. GIS manufacturer shall furnish all the required details in addition to those mentioned above necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS make, without any help of GIS manufacturer who has supplied the GIS equipment in present scope.

5.7.9.20 **Refer clause 5.5.4 of 6-51-0066**, Note that metallic bellows shall be provided for lateral and vertical alignment based on calculation.

5.7.9.21 **Refer clause 5.6 of 6-51-0066, following shall also be complied**

- i. The corona rings/ stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

- ii. The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests.
- iii. Type test reports of radio interference voltage (RIV) level shall be submitted for approval

5.7.9.22 **Refer clause 5.14.3 (a) and (d) of 6-51-0066**, Note that manual closing and opening of disconnector is not allowed.

5.7.9.23 **Refer clause 6.1.1 of 6-51-0066, following shall also be complied**

The circuit breaker shall be capable of

- i. Interrupting the steady and transient magnetizing current for transformers upto 150 MVA.
- ii. Interrupting line/ cable charging current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of  $U/\sqrt{3}$  and 1.4.
- iii. Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.
- iv. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energization of shunt reactor and/or series capacitor compensated lines with trapped charges.
- v. Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).
- vi. Circuit breakers shall be able to switch in and out the shunt reactor of rating upto 100 Ampere with maximum rise of overvoltage limited upto 2.3 p.u.
- vii. **Total Break Time** :The total break time shall not be exceeded under any of the following duties :
  - Test duties T10, T30, T60, T100 (with TRV as per IEC- 62271-100 )
  - Short line fault L90, L75 (with TRV as per IEC-62271-100 )

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

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

5.7.9.24 **Refer clause 6.1.5 of 6-51-0066, following shall also be complied**

- i. Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.
- ii. Provisions shall be made for attaching an operational analyser to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducer for substation covered under the scope.

5.7.9.25 **Refer clause 6.1.6 (b) (viii) of 6-51-0066, clause shall be read as**

Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits.

**5.7.9.26 Refer clause 6.1.6 (e) of 6-51-0066, following shall also be complied**

- i. As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
- ii. After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.
- iii. Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires preferably not more than 90 seconds for full charging of the closing spring.

**5.7.9.27 Refer clause 6.1.6 (c) of 6-51-0066, following shall also be complied**

- i. The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.
- ii. The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate no. of spare contacts, for continuous monitoring of low pressure, high pressure etc. at switchyard control room.
- iii. The mechanism shall be suitable for at-least two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.
- iv. The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up.
- v. Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for loss of Nitrogen shall also be provided.
- vi. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage

**5.7.9.28 Refer clause 6.2.1 of 6-51-0066, following shall also be complied**

- i. The signalling of the closed position of the Disconnecter shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.
- ii. The signalling of the open position of the Disconnecter shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.
- iii. Continuous current rating of the Safety earthing switch and high speed make proof earthing switches (not less than 100A) shall be specified by the manufacturer, which can be safely injected for Bay/ Bus equipment testing.

**5.7.9.29 Refer clause 6.2.4 of 6-51-0066, following shall also be complied**

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

**5.7.9.30 Refer clause 6.2.5 of 6-51-0066, following shall also be complied**

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

**5.7.9.31 Refer clause 6.3 of 6-51-0066, following shall also be complied**

- i. Surge arrester for GIS shall be installed within the GIS enclosure. Outdoor type surge arrester are not permitted.
- ii. The contractor shall be fully responsible for complete insulation co-ordination of substation including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected equipment. The locations of surge arrestors shown in single line diagram is indicative only. If at some more locations the surge arrestors are required to be provided the same should also be deemed included in the scope of work.
- iii. The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrester and shall demonstrate that the selected arrester's protective and withstand levels, discharge and coordinating currents and arrester ratings to comply with the requirement of specification.
- iv. The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.
- v. 245 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV system on two successive operations.
- vi. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- vii. Each arrester shall be fitted with an online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.

**5.7.9.32 Refer clause 6.4.2 of 6-51-0066, Note that LCC shall be powder coated.**

**5.7.9.33 Refer clause 6.6 of 6-51-0066, following shall also be complied**

- i. Current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120% (or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/ knee point voltage in case of relaying CTs.
- ii. The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably built in construction of the CTs.
- iii. Provisions shall be made for primary injection testing.
- iv. Note that 1.1 kV bushing mentioned in 6.6.4 for taking CT connections to terminal box is not mandatory.

**5.7.9.34 Refer clause 6.7 of 6-51-0066, following shall also be complied**

- i. VT's for GIS shall be installed within the GIS enclosure. Outdoor type VTs are not permitted.
- ii. The supplier shall ensure that there is no risk of Ferro resonance in inductive type voltage transformers, due to the capacitance of the GIS.

**5.7.9.35 Refer clause 6.9.4 of 6-51-0066, following shall also be complied**

For SF6 gas site tests for moisture, air content, flash point and dielectric strength to be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site. The contractor shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis. The contractor shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters. The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

**5.7.9.36 Refer clause 6.10.2 of 6-51-0066, following shall also be complied**

For "Compartments except Circuit Breaker" and for "Circuit Breaker" compartment, SF6 low level shall be used to annunciate the need for urgent gas filling. Zone trip level shall also be provided for circuit breaker compartment.

**5.7.9.37 Refer clause 6.10 of 6-51-0066, following shall also be complied**

The contractor should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device.

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

In case gas leakage under specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will give additional warranty for FIVE years.

**5.7.10** It is required to interface the GIS switchboards, LCC and CRP with the ECS Panel for control, monitoring and annunciation purpose. For ECS Interface, typical ECS IO list is attached. All the Bus PTs shall have four stages of under-frequency & df/ dt protection and separate contact for each stage shall be provided for ECS interface. In addition to above, terminals as required for interface with upstream and downstream switchgear needs to be provided to fulfil the operational requirements.

**5.7.11** For control of GIS switchboards through ECS, One Local/ Remote (L/R) selector switch shall be provided in each individual panel of GIS. Where Local means Operation from panel itself and Remote means ECS.

- When L/ R selector switch is in Local mode, all controls are transferred to GIS switchboard. Following operations shall be possible from the GIS
  - Closing of all incomers and bus coupler breakers in test position only.
  - Closing of all outgoing breakers in test and service position.
  - Tripping of all breakers, irrespective of position of Local/ Remote selector switch.

**5.7.12** Manufacturer shall furnish the following information for Owner's/ EIL review

- 5.7.12.1 Details regarding the loosely distributed metallic particles within the GIS encapsulation and calculations of critical field strength for specific particles of defined mass and geometry.
- 5.7.12.2 Study report of VFTO generated for GIS installation.
- 5.7.12.3 The methodology and all the equipment for electrical partial discharge (PD) detection.
- 5.7.12.4 The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure during detailed engineering.
- 5.7.12.5 The detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms
- 5.7.12.6 Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers
- 5.7.12.7 Design calculation for simulated parameters for Seismic level as applicable
- 5.7.12.8 Insulation Coordination studies including studies to recommend for additional surge arrester
- 5.7.12.9 Calculation in support of touch & step voltages in all enclosures and earthing of complete GIS installation.
- 5.7.12.10 Equipotential earth mat drawings along with design calculations.
- 5.7.12.11 Measures to mitigate transient enclosure voltage by high frequency currents.
- 5.7.13** All transport packages containing critical units viz. Circuit breakers and Voltage transformers shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge.
- 5.7.14** Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. Either dry nitrogen/ air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment. The type of gas, the maximum pressure to which sections will be filled prior to shipment and the minimum allowable pressure during shipment shall be advised prior to dispatch. Necessary arrangement shall be ensured by the contractor to take care of pressure drop of dry air or nitrogen during transit and storage till completion of erection.
- 5.7.15** Following equipments shall be supplied along with GIS (These equipments shall be supplied as Mandatory spare, defined elsewhere in this document)
- 5.7.15.1** **SF6 Gas leakage detector**
- The detector shall be portable, battery operated with built in battery charger, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The test kit shall be compatible for EMI/EMC environment as per IEC 1000. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication, and a head phone jack. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged substation.
- 5.7.15.2** **Gas filling and evacuating plant**

- i. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall be at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete Bay (switchgear and associated equipment) or continuous bus section (whichever is higher).
- ii. The minimum capacity of evacuation plant will be as under:
  - Vacuum Pump: 60 M<sup>3</sup>/Hour (Nominal suction pressure)
  - Compressor: 15 M<sup>3</sup>/Hour (Delivery).

#### 5.7.15.3 SF6 gas analyser

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

- i. In-built calibration facility.
- ii. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.
- iii. Equipment shall work on zero gas loss principle i.e. gas should be pumped back to the compartment after measurement without any exposure to the atmosphere.
- iv. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.
- v. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376
  - SF6 purity – Range: 0-100% & Accuracy: +/- 0.5 %
  - Dew point - Range : -60 to +20 °C & Accuracy: +/- 0.5 °C
  - SO2 - Range : 0-150 ppm & Accuracy : +/- 2 %
  - CF4 – Range : 0-60% volume & Accuracy : +/- 1 %
  - HF - Range : 0-200 ppm & Accuracy : +/- 5 %
- vi. Instrument should work on AC source as well as on rechargeable battery
- vii. Input pressure: upto 10 bar
- viii. It should be housed in a robust IP67 case with wheels

#### 5.7.15.4 Online Partial Discharge(PD) monitoring system for both indoor & outdoor GIS

- i. The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.
- ii. It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. The instrument should also be able to detect partial discharges in cable joints and terminations.
- iii. Detection and measurement of PD and bouncing particles shall be displayed on provided HMI for the system and the measurement shall be stored in the PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. Software for display and diagnosis of PD signals and an expert software system for accurate interpretation of cause of PD shall also be supplied and installed on the provided HMI by the contractor.
- iv. The equipment shall meet the following requirements
  - Measurement shall be possible in noisy environment.

- Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.
  - Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.
  - The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/ 50 Hz input.
  - Measurement shall be possible in the charged substation/ switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be furnished for evaluation during detail engineering.
  - Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Laptop PC, diagnostic and expert interpretation software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.
- v. The function of software shall be covering the following:
- Data recording, storage and retrieval in computer
  - Data base analysis
  - Template analysis for easy location of fault inside the GIS
  - Evaluation of PD measurement i.e. Amplitude, Phase Synchronization etc.
  - Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
  - Expert software system for accurate interpretation of cause of PD.
  - Report generation.
- vi. To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.
- vii. Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS
- viii. Calibration: The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/ frequency response characteristics shall be submitted for reference.
- ix. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

#### 5.7.15.5 SF6 topping system.

SF6 topping system shall be provided for 220 kV GIS for filling/ topping up SF6 gas to panel under energized condition manually.

#### 5.7.16 DC Control supply change over scheme for the EHV GIS shall be as per hardware datasheet B269-999-16-50-0119 attached with the tender document.

## 6 MISCELLANEOUS REQUIREMENTS

- 6.1 Equipment numbering scheme for equipment located in Substation shall be as per Design Basis document. Numbering scheme for other equipments shall be decided during detailed engineering.
- 6.2 Power system study shall be carried out in latest version of ETAP. CONTRACTOR shall furnish the native file of ETAP after carrying out the preliminary study and also along with the final report.
- 6.3 Wherever switchboards are provided with online temperature monitoring system, thermography window in cable chamber is not required.
- 6.4 CONTRACTOR shall furnish complete relay coordination and relay settings for the complete package including coordination with other EPCC CONTRACTOR / owner, relay settings for the upstream feeders.
- 6.5 Paint shade for indoor electrical equipment shall be RAL 7032, & for outdoor electrical equipment shall be RAL 7031.
- 6.6 Suitability of cable terminal boxes/chambers for the respective cables sizes / runs as per the approved cable schedule shall be ensured by the CONTRACTOR.
- 6.7 All nuts, bolts, washers, spring washers, grouting bolts, anchor fasteners, etc. necessary for completion of job wherever used shall be of stainless steel SS304. External hardware for lighting fixture, junction boxes, 230V receptacles, and lighting panel shall be of stainless steel grade SS304.
- 6.8 All lugs to be supplied shall be heavy duty, long barrel, crimping type and made of tinned copper. Sector shaped/circular barrel lugs shall be provided for making connections for cables having sector shaped/circular geometry of conductors respectively.
- 6.9 Cable tag shall be stainless steel with cable tag engraved. All spare holes at feeder end shall be sealed using metallic plate and GI hardware.
- 6.10 Cable glands shall be of nickel-plated brass. Cable glands shall be single compression type for indoor equipments & double compression type for outdoor equipments.
- 6.11 CONTRACTOR to note that 3D modelling of substation building and equipments shall be done by contractor in line modelling specification attached with tender. PDF/ Hard Copy of GA drawings of Owner's equipments to be installed in the substation shall be provided to CONTRACTOR during detail engineering
- 6.12 Wherever single core cables are to be terminated in switchboard, aluminum gland plates shall be provided.

## SECTION-2, Annexure\_1

अतिरिक्त उच्च वोल्टेज वाले  
गैस रोधित स्विचगियर  
के लिए विनिर्देश

### SPECIFICATION FOR EXTRA HIGH VOLTAGE GAS INSULATED SWITCHGEAR

| Rev. No | Date       | Purpose                                    | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---------|------------|--|-------------|------------|------------------------------|---------------------------|
| 1       | 29.03.2019 | REVISED & ISSUED AS STANDARD SPECIFICATION | JAS         | PG         | BRB                          | RKT                       |
| 0       | 30 01 2014 | ISSUED AS STANDARD SPECIFICATION           | AS          | PG         | UAP                          | SC                        |

Approved by

**Abbreviations:**

|         |  |                 |   |
|---------|--|-----------------|---|
| A       | : Ampere   | ICT             | : Interposing Current Transformer                 |
| AC      | : Alternating Current                                  | IEC             | : International Electro technical Commission      |
| AL      | : Aluminium  | IEEE            | : Institute of Electrical & Electronics Engineers |
| ASME    | : The American Society of Mechanical Engineers         | IP              | : Ingress Protection                              |
| BCU     | : Bay Control Unit                                     | IS              | : Indian Standards                                |
| BIL     | : Basic Insulation Level                               | kV              | : Kilo Volt                                       |
| BIS     | : Bureau of Indian Standards                           | kW              | : Kilo Watt                                       |
| BS      | : British Standards                                    | kWh             | : Kilo Watt Hour                                  |
| CB      | : Circuit Breaker                                      | LCC             | : Local Control Cabinet                           |
| CEA     | : Central Electricity Authority                        | LED             | : Light Emitting Diode                            |
| CENELEC | : Comité Européen de Normalisation Électrotechnique    | MCB             | : Miniature Circuit Breaker                       |
| CIGRE   | : Conseil International des Grands Réseaux Électriques | NEMA            | : National Electrical Manufacturers Association   |
| CNT     | : Close-Neutral-Trip                                   | NC              | : Normally Close                                  |
| CO      | : Close Open   | NO              | : Normally Open                                   |
| CRCA    | : Cold Rolled Cold Annealed                            | O               | : Open  |
| CRP     | : Control Relay Panel                                  | PO              | : Purchase Order                                  |
| CT      | : Current Transformer                                  | p.u             | : per unit  |
| Cu      | : Copper   | RAL             | : Reichs-Ausschuss fur Lieferbedingungen          |
| DC      | : Direct Current                                       | RIP             | : Resin Impregnated Paper                         |
| EHV     | : Extra High Voltage                                   | SF <sub>6</sub> | : Sulphur Hexafluoride                            |
| EIL     | : Engineers India Limited                              | SS              | : Stainless Steel                                 |
| EPDM    | : Ethylene Propylene Diene Monomer                     | TRV             | : Transient Recovery Voltage                      |
| FRLS    | : Flame Retardant Low Smoke                            | VDE             | : Verband Deutscher Elektrotechniker              |
| GIS     | : Gas Insulated Switchgear                             | VT              | : Voltage Transformer                             |
| GIBD    | : Gas Insulated Bus Duct                               | XLPE            | : Cross Linked Poly Ethylene                      |
| HV      | : High Voltage   |                 |   |
| Hz      | : Hertz  |                 |   |

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## 1.0 SCOPE

This specification covers the design, engineering, manufacture, testing, packing and supply of Extra High Voltage Gas Insulated Switchgear (GIS) & Gas insulated Bus duct (GIBD) for working voltages from 66 kV up to and including 400 kV complete with Local Control Cabinet (LCC), Control Relay Panel (CRP) and interconnecting cabling amongst GIS, LCC & CRP.

## 2.0 CODES AND STANDARDS

2.1 The GIS equipments / components used shall comply with the requirements of latest revision of the following standards and also the other Indian and International Standards as applicable, unless otherwise specified:

|                  |   |
|------------------|---|
| IS 1248          | Direct acting indicating analogue electrical measuring instruments and their accessories  |
| IS 2705          | Current Transformers  |
| IS 3156          | Voltage Transformers  |
| IS 4379          | Identification of contents of industrial gas cylinders  |
| IS 5082          | Material data for aluminium bus bars  |
| IS 5578          | Guide for marking of insulated conductors   |
| IS 11353         | Guide for uniform system of marking and identification of conductors & apparatus terminals  |
| IS 13703         | Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC   |
| IEC 60059        | IEC Standard Current Rating   |
| IS/IEC 60060     | High Voltage test techniques  |
| IEC 60099 -4     | Metal-oxide surge arresters without gaps for a.c. systems   |
| IEC 60114        | Recommendation for heat treated aluminium alloy bus bar material of Aluminium-Magnesium-Silicon type  |
| IEC 60137        | Bushings for alternating voltages above 1000 V  |
| IEC 60255        | Electrical Relays   |
| IS/IEC 60270     | High-voltage test techniques - Partial discharge measurements   |
| IEC 60376        | Specification of technical grade sulphur hexafluoride (SF <sub>6</sub> ) for use in electrical equipment  |
| IEC 60480        | Guidelines for the checking and treatment of sulphur hexafluoride (SF <sub>6</sub> ) taken from electrical equipment and specification for its re-use |
| IS/IEC 60529     | Degrees of protection provided by enclosures (IP Code)  |
| IEC 60694        | Common specifications for high-voltage switchgear and controlgear standards   |
| IEC 61243-1      | Live working Voltage detectors: Capacitive type to be used for voltages exceeding 1 kV A.C.   |
| IEC 61639        | Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above                          |
| IEC 61869-1      | Instrument transformers – General requirements  |
| IEC 61869-2      | Additional requirements for current transformers  |
| IEC 61869-3      | Additional requirements for inductive voltage transformers  |
| IS/IEC 62271-1   | High – Voltage Switchgear and Controlgear: Common specifications  |
| IEC 62271-4      | Handling procedures for sulphur hexafluoride (SF <sub>6</sub> ) and its mixtures  |
| IS/IEC 62271-100 | Alternating current circuit-breakers  |
| IS/IEC 62271-102 | Alternating current disconnectors (isolators) and earthing switches   |
| IEC 62271-104    | Alternating current switches for rated voltages of 52 kV and above  |
| IEC 62271-110    | High-voltage switchgear and controlgear - Inductive load switching  |
| IEC 62271-203    | Gas Insulated metal-enclosed switchgear for rated Voltages above 52 kV  |
| IEC 62271-209    | Cable connections for gas-insulated metal-enclosed switchgear for   |

IEC 62271-303 rated voltages above 52 kV-Fluid filled and extruded insulation  
IEEE 80 cables-Fluid filled and dry type cable terminations  
Use and handling of Sulphur hexafluoride (SF<sub>6</sub>)  
IEEE Guide for safety in AC substation grounding

**2.2** In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent or stringent than the applicable Indian standards.

**2.3** The equipment shall also conform to the provisions of CEA regulations with latest amendments and other statutory regulations currently in force in the country.

**2.4** In case Indian standards are not available for any equipment, standards issued by IEC/BS/VDE/IEEE/NEMA or equivalent agency shall be applicable.

**2.5** In case of any contradiction between various referred standard/ specification/ data sheet and statutory regulation, most stringent requirements shall prevail. However, Owner's decision in this regard will be final and binding.

### **3.0 GENERAL REQUIREMENT**

**3.1** The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

**3.2** Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

**3.3** Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

### **4.0 SITE CONDITIONS**

**4.1** The EHV GIS, GIBD & accessories shall be suitable for installation and satisfactory operation in a pressurised substation or in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.

**4.2** The switchgear shall be designed to operate under site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 metres above mean sea level shall be considered.

**4.3** All equipments are intended for continuous duty operation, as per nameplate rating under the specified ambient conditions, unless indicated otherwise.

### **5.0 DESIGN AND FABRICATION REQUIREMENTS**

#### **5.1 Enclosure and Protection**

**5.1.1** The switchgear shall be an indoor gas-insulated, metal enclosed design, assembled to form free standing, self supporting dead front structure. The degree of protection shall be at least IP4X for low voltage and drive mechanism compartments as specified in IS/IEC-60529. All openings, covers and doors shall be provided with suitable Neoprene / XLPE/ EPDM gaskets around the perimeter to make the switchgear dust and vermin proof.

**5.1.2** LCC, drive mechanism, CRP frame shall be fabricated using 2 mm CRCA sheet steel while doors and covers shall be made from 1.6 mm thick CRCA sheet steel.

- 5.1.3 The switchgear assembly shall consist of completely separate, SF<sub>6</sub> gas filled pressurized sections housing various switchgear components. The switchgear gas enclosures shall be sectionalised, with gastight barriers between sections / compartments. Gas enclosures shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes to which it is subjected in service (ASME/ CENELEC code for pressure vessel).
- 5.1.4 Each gas-filled compartment shall be equipped with static filters (e.g. molecular sieve or activated alumina or other absorbent), pressure switches, filling & draining valve with automatic shut off and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF<sub>6</sub> created during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.
- 5.1.5 The enclosures may be three phase enclosure or single phase enclosure as per the standard type tested design of the vendor.
- 5.1.6 The switchgear shall be of modular design and capable of extension in future by the addition of extra feeders without necessarily dismantling, moving or dislocating any major parts of existing switchgear bays. Design details for future extension shall be provided.
- 5.1.7 The enclosure for the SF<sub>6</sub> gas and associated circuit elements of enclosure shall be made from non magnetic material e.g. AL/AL alloy. Enclosures of the same phase shall be electrically interconnected, and shall be earthed at appropriate places. At appropriate points single phase enclosures should be connected to other phases, thus ensuring a return current path.
- 5.1.8 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions.
- 5.1.9 It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.
- 5.1.10 All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they cannot be operated easily, i.e. the operator shall use tools or brute force to over-ride them.
- 5.1.11 The switchgear earth buses shall have provision for connection to the plant earth grid running in the vicinity of the equipment.
- 5.1.12 The ladders, walkways and platforms with handrail shall be provided wherever necessary for access to the equipment. A portable ladder with adjustable height shall also be supplied for access to the equipment during operation & maintenance.
- 5.1.13 Any paints or other coatings that may be used shall be such that they will not deteriorate when exposed to the SF<sub>6</sub> gas and other vapours, arc products, etc. that may be present in the enclosures. They shall also not contain any substances which could contaminate the enclosed SF<sub>6</sub> gas or affect its insulating properties over a period of time.

## 5.2 Accessibility & Maintenance

- 5.2.1 Checking and removal of components shall be possible without disturbing adjacent equipment. All equipments shall be easily accessible. It shall be possible to set all measuring relays and instruments in-situ without de-energising the switchgear. All mounted equipment shall have identification tags of self sticking tapes at the rear also. In addition, identification numbers shall be painted on the panel wall to give a permanent identification mark.
- 5.2.2 All terminals shall be shrouded with plastic covers to prevent accidental contact.

- 5.2.3 GIS components shall be installed and arranged to facilitate realistic access for maintenance and removal of equipment, with a minimum amount of disturbance to other equipment meeting service continuity requirements.
- 5.2.4 It shall be generally possible to remove a circuit element (breaker, disconnect switch etc), without removing another element.
- 5.2.5 For routine inspection and possible repairs, all elements shall be accessible without removing support structures.
- 5.2.6 All special tools & tackles required for erection & maintenance of GIS & GIBD shall be provided by the vendor.

### 5.3 Service Continuity

- 5.3.1 The service continuity for GIS shall be ensured by appropriate sequence & location of feeders and by providing suitable gas compartment partitioning, additional gas buffer compartment, additional isolating links etc.
- 5.3.2 Following minimum requirements for service continuity shall be met:
- During a fault in any circuit breaker compartment, no bus bar is permitted to be out of service during maintenance, repair and replacement.
  - The bus bar enclosure shall be sectionalised in a manner that maintenance work in any section of bus bar can be carried out by isolating and evacuating that small section and not the entire bus. For fault in one bus bar & disconnecter compartment, at the maximum the adjacent feeders are permitted to be out of service during maintenance and repair. However the complete healthy bus / other bus shall remain operational for double bus GIS.
  - During a fault in any compartment other than circuit breaker or bus bar & disconnecter compartment, maximum affected feeder is permitted out of service during maintenance and repair.

### 5.4 Bus Bar

- 5.4.1 EHV GIS Bus configuration (Single Bus or Double Bus or One and half breaker scheme) shall be provided as specified in the data sheets/ Job specification.
- 5.4.2 Bus bars shall be of high conductivity electrolytic aluminium or copper.
- 5.4.3 The 3-phase bus bars shall be either housed in single phase enclosures or 3-phase enclosure as per vendor's design. All phase bus bars shall be of uniform cross-section and shall be sized to carry continuously the rated current specified in data sheet.
- 5.4.4 Bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current without any permanent deformation. All bus supports shall be of non-hygroscopic, non-inflammable, non-carbonising material, resistant to acids and alkalies.
- 5.4.5 Bus bar earthing facilities for each section of the bus bars, completely interlocked with associated disconnectors & CBs of that section of bus bars including bus coupler / bus sectionaliser shall be provided.

## 5.5 Expansion and Flexible Connection for Enclosure/ Conductors

- 5.5.1 Expansion joints / flexible connections shall be provided in each metal enclosure and conductors to absorb the actual or relative thermal expansion and contraction of the bus bar & equipments as well as structures resulting from variations of temperature of the switchgear equipment.
- 5.5.2 The number and position of the expansion joints / flexible connections shall be decided by the vendor to ensure that complete installation is not subjected to any expansion stresses which could lead to failure of any piece of the GIS equipment, supporting structures.
- 5.5.3 The electrical connections for the conductor expansion joints / flexible connections shall be made by means of multiple contact connectors preferably same as that provided at the joints between the separate gas compartments.
- 5.5.4 In addition, metallic bellows (preferably of stainless steel) shall be provided for lateral and vertical alignment.

## 5.6 Cable Termination

- 5.6.1 The SF<sub>6</sub> GIS to XLPE cable terminations shall conform to IEC-62271-209.
- 5.6.2 All power cables and control cables will be connected from below through cut-outs in the floor or through cable trench. Plug in terminations (including plugs, sockets) and all accessories shall be provided for power cables for all feeders including spare feeders by vendor.
- 5.6.3 Isolating links shall be provided in cable termination module for disconnection between GIS and cable during cable testing. Further suitable arrangements of test plug / socket shall be provided which will permit full dielectric testing for outgoing cable of all cable feeders including primary current injection test for current transformers. The voltage rating of test plug / socket shall be as specified in data sheet / job specification.
- 5.6.4 Unless otherwise specified, all control cables shall enter from the bottom. Supporting facilities shall be provided for clamping of control cables.
- 5.6.5 Single compression nickel plated brass cable glands & tinned copper lugs shall be provided by vendor for all cables to GIS assembly, LCC & CRP.

## 5.7 Pressure Relief Device

- 5.7.1 Pressure relief devices shall be provided in the each gas sections/ compartment to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs. Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided to prevent pieces of the diaphragm or plug from flying out or any dangerous SF<sub>6</sub> arc product gases escaping, in a manner that could endanger personnel present there.
- 5.7.2 Pressure relief shall be provided for all EHV compartments including SF<sub>6</sub> gas & air insulated enclosures. Relief into cable cellar/ trench shall not be provided.
- 5.7.3 The set points for the pressure relief device shall be lower than pressure withstanding capability of the enclosure with sufficient margin.

## 5.8 Indication & Verification of Circuit Breaker, Disconnecter & Earth Switch Position

- 5.8.1 Mechanical indicators mounted external to the equipment shall be provided on all circuit breakers, disconnectors and earth-switches, which shall clearly show whether the earth switches/ CBs / disconnectors etc. are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.
- 5.8.2 Viewing windows shall be provided for all disconnectors and earth switches so that the switch contact positions can be verified by direct visual inspection. Viewing windows shall be of type, whereby the open / close position can be checked without any danger to the eyes even when a flashover occurs at that time. Wherever the inspection windows are not accessible, sight glass endoscope shall be provided.

## 5.9 Foundation Channels & Supporting Frame Works

- 5.9.1 The panels shall be suitable for installation on base frame supplied by vendor along with foundation bolts. Amply dimensioned oblong holes shall be provided at the bottom of the panels for their installation on the base frame. The panels shall be suitable for tack welding and bolting directly to the base frame. The panels with base frame shall be suitable for installation on panel supporting frame through tack welding.
- 5.9.2 All supporting steel structures above grade level for switchgear bays and all panels including SF<sub>6</sub>/Air Bushing support, GIBD support, inspection platform etc. shall be provided by vendor.
- 5.9.3 Details of suitable embedment in the foundation floor as required for supporting the switchgear assembly and panels, necessary supporting framework, levelling screws, inspection platforms etc. to fasten the switchgear base frames to the embedments in foundation floor shall be provided by vendor. Vendor shall provide drawing showing all details of the embedded parts and installation details required on the floor.

## 5.10 Nameplates

- 5.10.1 Engraved nameplates shall preferably be of 3-ply (Black-White-Black) lamicoïd sheets or anodised aluminium. However back engraved perspex sheet nameplates are also acceptable. Nameplates shall be fastened by screws and not by adhesives. A weather proof and corrosion proof name plate shall be provided and shall conform to applicable standards.
- 5.10.2 A nameplate with the switchgear designation shall be fixed at the top of the central panel. A separate nameplate giving details of each feeder compartment of all panels shall be provided. Danger plate (Red) shall be provided at the front and rear for each panel.
- 5.10.3 Blank nameplates shall be provided for all spare feeders.
- 5.10.4 Each of the equipment devices including CB, Disconnecter switch, Earthing switch, CT, VT and busbars etc. mounted inside the switchgear shall be provided with proper nameplate and rating plate. All information as per the latest edition of relevant IEC standards shall be included. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.
- 5.10.5 Special warning labels shall be provided inside the switchgear also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

## 5.11 Painting, Protective Finish / Corrosion Protection of Surfaces

- 5.11.1 The switchgear shall be treated and protected to withstand continuous operation under site conditions without sustaining corrosion or attacks from fungus or rodents. The protective finish shall prevent deterioration due to corrosion, humidity, temperature, ageing and weather etc. under site conditions.
- 5.11.2 All metal surfaces shall be thoroughly cleaned & degreased to remove mill scale, rust, grease and dirt. All exterior surfaces shall be cleaned and epoxy painted before leaving the factory with one coat of approved primer and two coats of approved equipment finish paint. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. Alternately, vendor's standard paint procedure for manufacturing is also acceptable. The underside of all surfaces bearing upon the concrete foundation shall be given two coats of approved primer. The under surface shall be made free from all imperfections before undertaking the finishing coat.
- 5.11.3 The exterior surface finish of switchgear paint shade shall be RAL-7032 unless specified otherwise.
- 5.11.4 The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint (1 litre per switchboard) in non-returnable container for final touch up at site.
- 5.11.5 Supporting frame work shall be hot dip galvanised after fabrication.
- 5.11.6 All unpainted steel parts shall be Zinc passivated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.
- 5.11.7 Gas monitoring and service piping including all fittings and accessories shall be made of copper, brass or stainless steel.
- 5.11.8 Electrolytic corrosion shall be avoided in joints of different metals. Before the metal enclosed sections are joined together and charged with the SF<sub>6</sub> gas, they shall be thoroughly cleaned.

## 5.12 Auxiliary Cabling, Wiring and Terminals

- 5.12.1 Owner interface for remote control, metering, indication, alarm etc. of complete GIS equipment shall be at CRP only. Further external AC & DC control & auxiliary power supplies interface for complete GIS equipment shall be at designated LCC only.
- 5.12.2 All cables required amongst various components of GIS i.e. circuit breaker, disconnectors, earth switches, CT, VT, LCC, CRP etc. along with the cable glands & lugs shall be provided by the vendor. The cables shall be Cu conductor, FRLS, armoured type. These shall be suitable for directly laying in cable trays/ lined RCC trenches. Maximum distance between GIS/LCC and corresponding CRP shall be considered as 150 meters unless otherwise specified. Exact distances shall be informed during vendor drawing review based on the final locations of GIS/LCC and CRP.
- 5.12.3 Inside the cubicles, the wiring for control, signalling, protection and instrument circuits shall be done with FRLS type, copper conductor wire. The insulation grade shall be 660V. The wiring shall preferably be enclosed in plastic channels or neatly bunched together. Flexible conduits shall be provided for routing wiring between various compartments.
- 5.12.4 A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends before connections are made to the

terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare contacts of CB, switches, auxiliary relays etc shall be wired up to the terminals.

- 5.12.5 Each wire shall be identified at both ends by correctly sized ferrules. The CT terminal blocks shall have shorting, isolation and injection test facilities whereas VT terminals shall have isolation and injection test facilities.
- 5.12.6 Copper conductor of cross section  $1.5 \text{ mm}^2$  may normally be used for control fuse rating 10 amps or less. For 16 amps control fuse circuit,  $2.5 \text{ mm}^2$  copper conductors shall be used. CT Circuit wiring shall be done with  $2.5 \text{ mm}^2$  copper conductors.
- 5.12.7 All inter-panel control wiring within each shipping section shall be done at vendor works. The inter-panel wiring shall be taken through sleeves or suitable grommets. For inter-panel wiring between the shipping sections, wires in rolls of the required length, connected at one point, shall be supplied with the panel by vendor for connection at site.

### 5.13 Earthing

- 5.13.1 The earthing system shall be designed and provided as per IEEE-80 and CIGRE- 44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences. The earthing system shall ensure safe touch & step voltages in all the enclosures.
- 5.13.2 Vendor shall provide copper earth buses and copper earth conductors & associated hardware material for connecting all GIS equipment, earthing switches, surge arrestors, VT neutral, CT leg, enclosures, cabinets, boxes, supporting structure, platforms & hand rails, operating handles of disconnecter & earth switches etc. to the earth buses of GIS.
- 5.13.3 The GIS enclosures shall be of continuous design and shall meet the requirements as specified in clause no. 10 (special considerations for GIS) of IEEE- 80. The GIS shall be earthed at several points so that there shall be earthed cage around all the live parts. Wherever earth continuity is not maintained by GIS inherent design, each enclosure shall be effectively interconnected with 2 nos. Cu bonds of suitable size to bridge the flanges.
- 5.13.4 LCC, CRP, power and control cable sheaths and other noncurrent carrying metallic structures shall be connected to the earthing grid. At least two earthing paths shall be provided to connect each point to the GIS earth bus.
- 5.13.5 Minimum earth bus size of  $300 \text{ mm}^2$  copper for earthing of GIS equipment shall be provided.
- 5.13.6 All flexible earthing leads shall be of copper.
- 5.13.7 The earthing of Surge arrestor shall be provided with green PVC coated Cu braided cable up to the main earth grid. The size of the conductor shall be such that all the energy is dissipated to the earth without getting overheated.

### 5.14 Interlocks

- 5.14.1 The interlock system shall positively prevent an Operator from reaching or creating unintentionally a dangerous or potentially dangerous condition.
- 5.14.2 All interlocks required between circuit breakers, disconnectors and earth switches shall be provided.

5.14.3 Specifically the following conditions shall be impossible to reach:

- a) Electrically and manually closing or opening of the disconnecter / earthing switch while the circuit breaker is closed.
- b) Electrical closing of disconnecter/ circuit breaker, while the earthing switch at the remote end is closed.
- c) Electrical closing of earthing switch while the remote end disconnecter/circuit breaker is in closed position.
- d) Electrical & manually closing of bus bar disconnectors of any circuit while the bus bar earthing switch is closed.

5.14.4 When the manual emergency cranks are used, it shall be impossible to control the devices electrically.

5.14.5 Bus VT Miniature Circuit Breaker (MCB) ON auxiliary contacts and under voltage relay contacts shall be monitored in the interlocking scheme to confirm the dead bus condition.

5.14.6 Bus-bar disconnectors of any circuit shall not close electrically or manually while a Bus-bar Earthing Switch is closed.

## 5.15 Space Heaters

5.15.1 CRP, LCC & drive mechanism box shall be provided with space heaters to prevent moisture condensation and maintain cubicle temperature 5°C above the ambient. The space heaters shall be controlled through a double pole MCB and thermostat. Space heaters shall be supplied from 240V AC auxiliary supply.

## 6.0 SWITCHGEAR COMPONENTS

### 6.1 Circuit Breakers

#### 6.1.1 General

- a) The circuit breakers shall be in 3 phase enclosure or single phase enclosure as per vendor standard design. They shall be electrically, mechanically, hydraulically trip free as applicable and anti-pumping with both of the trip circuits connected.
- b) Pole discrepancy tripping shall be provided which shall detect discrepancy in opening of contacts. Local electrical operation shall be provided from the local control cabinet. An emergency manual trip device & mechanical operation counter shall be provided in the breaker kiosk. The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies.

#### 6.1.2 Duty Cycle (Operating Mechanism)

- a) Circuit breaker shall be C2 - M2 class as per IEC 62271-100.
- b) Circuit breaker shall meet the duty requirements for any type of fault or fault location & also for line charging and dropping as applicable and perform make and break operations as per the stipulated duty cycles satisfactorily.
- c) The CB shall be suitable for carrying out the duty cycle of O-0.3 seconds-CO-3.0 minutes – CO.

### 6.1.3 Pre-Insertion Resistor (applicable for 400 kV GIS)

The circuit breakers for transmission line bay shall be provided with single step pre insertion closing resistors/Controlled switching devices to limit the switching surges to a value of less than 2.3 p.u. The value of the pre-insertion resistor and the duration of pre-insertion time shall be as designed by vendor.

### 6.1.4 Construction Features

- a) The circuit breakers shall be SF<sub>6</sub> type. The circuit breakers shall be of single pressure type / self blast type and shall utilise puffer cylinder for arc interruption. Each SF<sub>6</sub> CB pole shall preferably be with single interrupting chamber. Each SF<sub>6</sub> circuit breaker pole shall be provided with its own self-contained gas system.
- b) The service connections for gas handling shall be located on each pole tank to facilitate servicing. The breaker shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics, complete drying of container and breaker, selection of 'O' ring, etc.
- c) Materials such as activated alumina or molecular sieve shall be provided at appropriate locations as moisture absorbents. Also suitable absorbents for removing SF<sub>6</sub> arc products shall be employed.
- d) Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

### 6.1.5 Breaker Contacts

- a) Main contacts shall be of copper with silver plating and have ample area & contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall have a minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.
- b) Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping. Provision shall be made for rapid dissipation of heat generated by the arc on opening.
- c) If multi-break interrupters are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them.

### 6.1.6 Operating Mechanism

- a) General Requirements
  - i. Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these.
  - ii. Main poles shall operate simultaneously. The design of the circuit breaker shall be such that contacts will not close automatically upon loss of gas / hydraulic pressure.

- iii. The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.
- b) Operating Mechanism Control
- i. The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.
  - ii. Two (2) independent tripping circuits, valves, pressure switches, and coils shall be provided for each operating mechanism.
  - iii. For all HV Variable frequency drive feeders, breaker shall be additionally provided with under voltage release. However, in case it is not possible to provide under voltage release in the standard design, as an alternative, one shunt trip coil shall be suitable for DC control supply while second shunt trip coil shall be suitable for external AC control supply. The control supply voltage level shall be as specified in datasheet.
  - iv. A local manual closing device shall also be provided for maintenance purpose. Direction of motion of handle shall be clearly and indelibly marked.
  - v. Electrical tripping shall be performed by shunt trip coils. Provisions shall be made for electrical control from LCC & CRP.
  - vi. The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker.
  - vii. Breaker tripping, closing and spring charging devices shall be fed with DC control power supply. Closing coil and associated circuits shall operate correctly at all values of control voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker at all values of supply voltage between 70% and 110% of rated voltage.
  - viii. Pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts shall be used for each of tripping and closing circuits.
  - ix. The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.
  - x. The breakers shall have at least 6 normally open (NO) and 6 normally closed (NC) spare auxiliary contacts for Owner's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.
- c) Hydraulic Operated Mechanism
- i. Hydraulic operated mechanism shall comprise self contained operating unit with power cylinder, control valves, high and low pressure reservoir, pressure gauge, necessary piping, compressor and motor, etc. A hand pump set shall also be provided for emergency operation.
  - ii. The piping shall be seamless type and of non-corrodible material such as SS or Brass. The joints shall be welded except at the equipment terminal ends.
  - iii. Oil required for initial filling including make up of usual losses during commissioning and leakages shall be supplied by vendor.
- d) Hydraulic Monitoring Device:

- i. Hydraulic pressure system shall be monitored as follows:
    - "Hydraulic first level": this gives an alarm if, after a predetermined time interval, the hydraulic pressure is not returned to its nominal setting. Pressure switch contact to open for alarm.
    - "Hydraulic second level": this will give an alarm indication if the pressure drops below the minimum operable pressure, i.e. mechanism locks out.
    - Hydraulic motor Excessive start: alarm to be provided.
    - Hydraulic motor: excessive running of motor alarm to be provided.
  - ii. 'Motor on overload' condition shall be tripped and 'trip' and 'supply failure' conditions shall be annunciated. In the event that non bio-degradable fluids are used, containment trays shall be provided to prevent a spillage.
- e) Spring operated Mechanism
- i. Spring operated mechanism shall be complete with motor. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
  - ii. Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided.
  - iii. Closing action of circuit breaker shall compress the opening spring ready for tripping.
  - iv. When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the LCC.
  - v. Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.
  - vi. A mechanical indicator shall be provided to indicate the status of the spring. The indication shall be visible with the doors of the mechanism cabinet closed.
  - vii. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in closed position.
  - viii. The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

## 6.2 Disconnectors & Earthing Switches

### 6.2.1 General

- a) Disconnectors and Earthing switches shall be of single-pole, group operated type, installed in the switchgear to provide electrical isolation with one motor operated mechanism per three poles. The disconnectors and earth switches shall conform to IEC- 62271-102.
- b) Disconnector shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordance with Annexure –B of IEC: 62271-102.
- c) The disconnector shall be M1 class operated.

- d) High speed make proof earthing switches shall be E1 class operated. Safety earthing switches shall be E0 class operated.
- e) Electric motor shall be suitable for DC control supply and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit. The associated circuits shall operate correctly under all values of supply voltage between 85% and 110% of rated voltage.
- f) Disconnectors shall be suitable to make and break the charging currents during their opening and closing. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

#### 6.2.2 Constructional Features

- a) The disconnector shall be provided with high current carrying contact surfaces of silver faced copper/silver faced aluminium.
- b) Arrangement shall be provided to permit manual operation of the disconnectors & earthing switches. Whenever the manual handle is inserted into the drive mechanism, it shall not be possible to control the device electrically. Manual operating handle shall be provided with pad lock. The contacts shall be both mechanically and electrically disconnected during the manual operation.
- c) The disconnectors shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.
- d) The disconnectors and safety earthing switches shall have a mechanical key (pad locking key) and electrical inter-locks to prevent closing of the earthing switches when disconnectors are in the closed position and to prevent closing of the disconnector when the earthing switches are in the closed position.
- e) The disconnectors & earth switches shall be capable of being padlocked in both fully open and fully closed positions with the operating motor automatically disengaged. The padlock shall be visible and directly lock the final output shaft of the operating mechanism.
- f) One man shall be able to operate the disconnector /earthing switch (when manually operated) without undue effort.

#### 6.2.3 Operating Mechanism Control

- a) Disconnectors and earthing switches shall be motor operated, with limit switches and controlled from the LCC and CRP. Connections, interlocking requirements and auxiliary switches shall be provided as per the requirements.
- b) The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.
- c) Each disconnector, earth switch shall have at least 4 normally open (NO) and 4 normally closed (NC) spare auxiliary contacts for Owner's use.

#### 6.2.4 Additional Requirements for Safety Earthing Switches

- a) Earthing switch, whenever possible can form an integral part of each pole of the disconnector. Two independent earthing pads each with flexible copper braids and suitable connectors for the specified size of earth conductor lead shall be provided at the hinge end of the earthing switch.

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

### 6.2.5 Additional Requirements for High Speed Make Proof Earthing Switches

- a) High speed make proof earthing switch shall have make proof contacts and high speed stored energy operating mechanism to enable them suitable to close on to a fault.
- b) High speed earth switches shall be motor driven stored energy operated. After removal of the earthing initiated by a fault making earth switch, it shall be possible to re-energize the system without first carrying out the maintenance.
- c) The short circuit making current rating of each earthing switch shall be at least equal to its peak withstand current rating as applicable. The switches shall have inductive/ capacitive current switching capacity as per IEC62271-102.
- d) All portions of the earthing switches and operating mechanism required for connection to earth shall be connected together utilizing copper conductor.
- e) The main earthing connection on earthing switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the earthing grid.

### 6.3 Surge Arrestors

6.3.1 The surge arrestors shall conform in general to IEC 60099-4.

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

6.3.3 The surge arresters shall be capable of discharging over-voltages occurring during switching, lightning impulse etc.

6.3.4 The surge arresters shall be provided with a discharge counter located at an accessible position.

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

### 6.4 Local Control Cabinet

6.4.1 Local Control Cabinet (LCC) for each bay shall be supplied. LCCs shall be either separate free-standing floor mounted type panel or mounted on GIS assembly as per vendor's standard design. If separate LCCs are provided, these will be located next to GIS.

6.4.2 LCC shall be in dust and vermin proof hot dipped galvanised sheet steel construction. Hinged doors giving access to the components shall be provided.

6.4.3 Local control of all CBs, disconnectors & earthing switches shall be possible from LCC through control switches & selector switches with all associated interlocks. Local/ off / Remote selector switch shall be provided in LCC panel. LCC panels shall house alarms and facia annunciation etc. of GIS including GIS gas pressure system. The LCC shall also be used for termination of CT and PT cables from GIS bay.

6.4.4 Two (2) numbers of 415V, TPN, 50 Hz, power supply feeders will be provided by Owner at one location in the LCC for complete switchgear. Further power supply distribution for each LCC and to CRP shall be done by vendor.

- 6.4.5 Two (2) numbers of DC supply feeders will be provided by Owner at one location in the LCC for complete switchgear. Further DC power supply to each LCC and to each CRP shall be done by vendor.
- 6.4.6 The incoming external control supplies (AC & DC) shall be monitored continuously and alarm shall be given on failure. Vendor shall supply all necessary equipment and control for automatic change over from one source of control supply to the other in the event of failure of one source / contactor drop out.
- 6.4.7 An isolating switch for disconnection of power supply, open/close push buttons, magnetic contactor with thermal overload relays and HRC link type fuses for short circuit protection shall be provided in LCC for each individual motor of CB, disconnecter and earth switch.
- 6.4.8 Local Alarm & Annunciation**
- a) Alarm contacts shall be provided for monitoring of all vital systems of each circuit breaker and SF<sub>6</sub> gas system.
  - b) Window type alarm annunciation shall be provided on LCC of each bay for the various abnormal conditions.
  - c) Potential free electrical contacts shall be provided for remote alarm / indication of all alarm condition. These contacts shall be in addition to those required for local indication. These shall be wired to the terminal blocks in the LCC.
  - d) The following minimum number of abnormal conditions shall be annunciated.
    - i. Gas refill level for each gas compartment of the bay. (low gas pressure)
    - ii. Breaker Block level for each gas compartment of the bay. (low low gas pressure)
    - iii. Zone isolation level for each gas compartment of the bay.
    - iv. Over pressure for each gas compartment of the bay.
  - e) In addition to the minimum abnormal conditions listed above, any other abnormal condition as per the vendor shall also be annunciated.
  - f) Mimic diagram preferably shall be provided.
- 6.4.9 All current transformer leads shall be terminated on shorting type terminal blocks in the LCC and shall be accessible at all times. All voltage transformer leads shall be terminated and protected by MCB.
- 6.4.10 All other devices shall be wired to terminal blocks provided in the LCC. The terminal blocks shall have minimum 10% spare terminals per cabinet.

## **6.5 Control Relay Panels**

- 6.5.1 Separate Control Relay Panel (CRP) for each bay shall be supplied to facilitate control of circuit breakers, disconnectors, earth switches and metering, protection etc.
- 6.5.2 CRP shall be free-standing floor mounted type panel and shall be located either in GIS hall or in a separate room from GIS. CRP shall be in dust and vermin proof hot dipped galvanised sheet steel construction preferably modular swing rack type.
- 6.5.3 A mimic diagram shall be provided on the front of the panel with control switches and position indicators for CB, disconnecter and earth switches. The panel shall be dead front type with front

door having clear glass cut-out of adequate size so that mimic diagram, annunciator windows, indicating lamps are clearly visible from outside.

6.5.4 CRP shall house bay control units (BCUs) and protection relays. These panels shall also house the various selector switches, auxiliary relays, timers, local indications, alarms and facia annunciation window etc. to realise various interlocks as per requirement among circuit breakers, disconnectors and earth switches and for breaker pole discrepancy, anti-pumping etc. It shall include the following as minimum:

- a) Local / remote selection switch
- b) CNT control switch for breaker
- c) Breaker ON, OFF, Trip-1, Trip-2, Trip circuit healthy indications
- d) Disconnector & earth switches ON, OFF control switches & indications
- e) Upstream breaker ON, OFF indication (for incomers)
- f) DC supply healthy indication
- g) Spring charging devices status
- h) Aux. relays / other devices as required by the design.

6.5.5 Completely separate and isolated circuits shall be used for each operating mechanism control, trip-1, trip-2, close, alarms and auxiliary devices. Close and trip circuits shall be kept isolated to their final mechanical or electrical actuators from the CRP terminals.

6.5.6 Trip circuit-1 & trip circuit-2 shall be individually monitored for continuity under open and closed condition of breaker. Closing circuit shall be monitored under open condition of breaker.

6.5.7 The contacts and signals originating from/going to the GIS, associated auxiliary and monitoring equipment shall be wired up to the CRP for external use.

#### 6.5.8 Measuring Instruments

Meters shall be of electronic or induction- disk type, flush-mounted on the cubicle door. All analogue instruments shall be of square pattern, 96 x 96 mm, flush-mounted type. Measuring instruments, shunts, transducers, CTs, VTs, etc, shall be provided as specified in data sheet. The accuracy class for all instruments shall be 1.0 unless otherwise specified.

Digital meters shall also be acceptable, provided specific approval of EIL/Owner for make and model is obtained. All digital meters shall be highly reliable, accurate, and compact and self powered. Digital meter data shall be saved in case of power failure. Field programming from front of the meter shall be possible and shall have RS232/485 port in case specified in the job specification / data sheet.

- a) Ammeters and Voltmeters

Analogue meters shall be of moving-iron type. The range shall be indicated on the drawings.

- b) kW / kWh Meters

The kW / kWh meters shall be suitable to measure unbalanced loads on a 3-phase, 3-wire system. The kW meters shall operate on a VT secondary voltage of 110 V.

- c) Frequency Meters

These shall be of direct-reading or digital type and shall operate on a VT secondary voltage of 110V. The standard range shall be 45-50-55 Hz.

- d) Power Factor Meters

Power factor meters shall operate on a VT secondary voltage of 110 V. The standard range shall be 0.5 lead-1.0-0.5 lag.

#### 6.5.9 Relays

- a) Type of relay i.e. electromechanical, static or numerical / bay control unit shall be as defined in datasheet / job specification.
- b) All electromechanical protective relays shall be back-connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays are acceptable in fixed execution.
- c) The protective relay cases shall have a provision for insertion of a test plug at the front for testing and calibration using an external power supply without disconnecting the permanent wiring. The insertions of the test plug shall automatically short circuit the CTs and permit extension of external power supply to the relay.
- d) All protective relays shall have hand reset facility and clear operating indication, e.g. flags for electro-mechanical type relays or light emitting diodes for static/numerical type relays. It shall be possible to reset the flag without opening the relay case.
- e) All tripping relays shall be of lockout type with hand-reset contacts, and shall be suitable to operate on the specified voltage. These relays shall have self coil cut off contacts, and shall be provided with hand-reset operation indicators. Tripping relays will be acceptable in non-drawout cases.
- f) The tripping relay shall be suitable for satisfactory operation from 50% to 110% of the specified control supply voltage.
- g) Numerical relays /bay control unit shall be equipped with communication port to work as an integrated part of the substation automation system. Multifunctional device (bay control and protection unit) shall be with control, indication, metering, protection, mimic, communication/ interface functions.
- h) Stabilizing resistors shall be provided along with relays, wherever required, to limit the secondary voltage of current transformer to safe level during maximum internal fault condition. Further Stabilizing resistors shall be provided with relays including numerical relays in residual earth fault connections to prevent any spurious tripping during starting.

#### 6.5.10 Alarm & Annunciation

- a) Potential free electrical contacts shall be provided for remote alarm / indication of all alarm/trip condition. These contacts shall be in addition to those required for local indication at LCC. These shall be wired to the terminal blocks in the CRP.
- b) The following minimum no. of abnormal conditions shall be annunciated.
  - i. Hydraulic motor overload / circuit trouble
  - ii. Hydraulic first level (low hydraulic pressure)
  - iii. Hydraulic second level (Low-Low Hydraulic pressure)
  - iv. Disconnecter/ earth switch motor overload (one per each bay)
  - v. Circuit breaker motor overload (one per each bay)
  - vi. DC control supply failure
  - vii. Common gas alarm for the bay
- c) In addition to the minimum abnormal conditions listed above, any other abnormal condition as per the vendor shall also be annunciated.

6.5.11 Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications. The LED shall have a low glow voltage protection and shall not glow on voltage leakage.

6.5.12 All other devices shall be wired to terminal blocks provided in the CRP. The terminal blocks shall have not less than 10% spare terminals per panel.

## 6.6 Current Transformers

6.6.1 The current transformers and accessories shall conform to IEC: 61869-1&2 and other relevant standards.

6.6.2 The CT short time rating shall be equal to that of the switchgear. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of 5P and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. For numerical relays having protection and metering functions, dual rated CT shall be provided suitable for protection class and metering class. One leg of CTs shall be earthed.

6.6.3 The current transformers shall be of metal- enclosed and shall be given tropicalised treatment for satisfactory operation in hot and humid climate. The current transformers shall have effective electromagnetic shields to protect against high frequency transients.

6.6.4 The CT secondary terminals shall be brought outside the EHV enclosures through a bushing of 1.1 kV class and mounted in accessible terminal box. All secondary leads shall be wired to shorting type terminals on the terminal strip in the local control cabinet of each breaker bay. All terminals shall be shrouded with plastic covers to prevent accidental contact.

6.6.5 All CTs shall be star connected. Interposing CT (ICT) shall be provided (if required) for differential protection of transformers having star-delta connection.

6.6.6 The polarity of the primary and secondary windings of each current transformer shall clearly be indicated.

## 6.7 Voltage Transformers

6.7.1 The voltage transformers shall conform to IEC 61869-1&3.

6.7.2 The voltage transformers shall be of inductive type, non-resistant and shall be contained in their own compartment. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients.

6.7.3 Voltage transformer secondary shall be protected by 4 pole MCB for all the windings. The secondary terminals of the VT's shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes.

6.7.4 The terminals of the secondary winding shall be brought out of the enclosure through 1.1 kV class bushing. Secondary terminals of each phase shall be located in accessible earthed terminal box on the VT enclosure itself. Neutral side of HV winding shall be brought out through a bushing rated for at least 1.1 kV class and located in a terminal box.

## 6.8 Auxiliary equipment

### 6.8.1 Auxiliary Relays and Contactors

- a) Auxiliary relays and contactors shall generally be used for inter-locking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum anticipated current.

### 6.8.2 Control Switches

- a) All control switches shall be rotary type, having a cam-operated contact mechanism. Circuit breaker control switches shall be 3-position CNT, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles.
- b) The Local/off/remote switch shall be three positions type, lockable, key free in remote positions only with the following functions:
- Local position (the breaker, disconnecter and earthing switches can only be operated locally by its control switches).
  - Off position (the breaker, disconnecter and earthing switches cannot be operated electrically).
  - Remote position (the breaker and disconnecter can only be operated from Remote).
- c) Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions, three positions for reading 3-phase currents and the fourth position for OFF. The voltmeter selector switch shall also have four positions, three positions shall be used to measure phase-to-phase voltages and the fourth position shall be for OFF.

### 6.9 SF<sub>6</sub> Gas

- 6.9.1 SF<sub>6</sub> gas shall comply with the requirements of IEC 60376, 60376A & 60376B as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions. The high pressure cylinders in which SF<sub>6</sub> gas is supplied & stored at site shall comply with the requirements of IS:4379. The cylinders shall also meet the Indian Boilers Regulations.
- 6.9.2 SF<sub>6</sub> gas necessary for initial filling (including entire losses, if any, during HV testing, Pre-commissioning / commissioning) and make-up gas for leakages of the complete switchgear shall be supplied by vendor.
- 6.9.3 The initial gas pressure or density at the time of charging the equipment shall provide a 10% margin above the allowable operating pressure for the plant to be safely operated for a reasonably long period before recharging is necessary.
- 6.9.4 SF<sub>6</sub> gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IS 13072/IEC 60376, 60376A & 60376B and test certificates shall be furnished indicating all test results as per IEC standards for each lot of SF<sub>6</sub> gas.
- 6.9.5 In addition 10% of total gas requirement shall be supplied in separate non-returnable cylinders as spare requirement by vendor.

### 6.10 SF<sub>6</sub> Gas Monitoring Devices and Alarm Circuits

- 6.10.1 All gas compartments shall have their own independent gas supervision and alarm systems. There shall not be any interconnection between different gas compartments for the purpose of gas monitoring.
- 6.10.2 Individual temperature compensated gas pressure gauge(s)/ density device(s) shall be provided in each of the gas compartments which will continuously & automatically monitor and indicate the state of gas density as follows:

- a) Compartments except circuit breaker
- i. 'Gas Refill' level  
This will be used to annunciate on the LCC and CRP the need for the gas refilling.
  - ii. 'Zone Trip' level  
This is the minimum level at which the vendor will guarantee the insulation rating of the assembly (i.e. one minute power frequency voltage, BIL specified). At this pressure level it will be annunciated on the LCC/ CRP so that manual tripping of the circuit should be done.
- b) Circuit Breaker
- i. 'Gas Refill' level  
This will be used to annunciate on the LCC and CRP the need for the gas refilling.
  - ii. 'Breaker Block' level  
This is the minimum gas density at which the vendor will guarantee the rated fault interrupting capability of the breaker. Beyond this level the device contacts lock out the breaker (trip and close operation) circuits and annunciate the condition on the LCC & CRP for the need of manual zone tripping.
- c) High pressure interlock and monitoring device shall be provided.
- d) Necessary contacts for remote annunciation shall be provided.
- 6.10.3 Vendor shall provide an independent pressure switch for isolation of the particular zone. This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.
- 6.10.4 Pressure switches and pressure gauges / density devices shall be located at accessible location suitable for viewing.
- 6.10.5 It shall be possible to test all gas monitoring devices without de-energising the primary equipment and without reducing pressure in the main section.
- 6.10.6 Gas Leakage Loss**
- a) Maximum guaranteed gas leakage loss of the switchgear shall be in no case be more than 0.5% per year over the life time of the switchgear. Initial filling of equipment shall guarantee gas service period of not less than 10 years.
  - b) All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. All gas seals located in the flanges of the equipment enclosures shall be of the O -ring type.
- 6.11 SF<sub>6</sub> Gas Handling Unit / Service Cart**
- 6.11.1 Portable SF<sub>6</sub> gas handling & processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF<sub>6</sub> gas during the initial installation, subsequent maintenance and future extension of GIS shall be provided. The cart shall be equipped with rubber wheels and shall be easily manoeuvrable within the building.
- 6.11.2 The unit shall be self-contained suitable for 415 V AC, 3-phase, 50 Hz power supply and fully equipped with an electric vacuum pump, gas compressor, gas drier, gas filter, refrigeration unit, evaporator, gas storage tank, full instrumentation for measuring vacuum, compressor inlet

temperature, tank pressure and temperature, valving and piping to perform the following operations as a minimum requirement:

- Evacuation from a gas filled compartment using the vacuum pump,
- Transfer of SF<sub>6</sub> gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter,
- Recirculation of SF<sub>6</sub> gas in the storage tank through the drier,
- Recirculation of SF<sub>6</sub> gas in any Switchgear or bus duct compartment through the drier and filter,
- Evaporating and filling SF<sub>6</sub> gas,
- Drawing off and liquefying SF<sub>6</sub> gas,
- A combination operation of filling SF<sub>6</sub> gas into a gas system and evacuating a second, gas system using the vacuum pump.

6.11.3 The unit shall be complete with all necessary instrumentation and control which may include instruments such as decomposition tester, hygrometer, and test unit for the density monitors, precision pressure / density gauge and vacuum gauge.

6.11.4 The unit shall include necessary gas cylinders for replenishment and for temporary storage of the evacuated SF<sub>6</sub> gas. The capacity of the storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from the largest compartment of GIS + 10% extra SF<sub>6</sub> gas when carrying out maintenance or repair work on the switchgear and associated equipment.

6.11.5 Adequate length of hoses shall be provided for filling of SF<sub>6</sub> gas in any of the gas compartment with the help of service cart.

## 6.12 Insulators & Gas Seals

6.12.1 The support insulators and section barriers/ insulators shall be of solid moulded composite epoxy resin. They shall be free from all voids and with smooth surface and the design shall be such so as to reduce the electrical stresses in the insulators to a minimum.

6.12.2 Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier, i.e. with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over-pressure, equal to the operating pressure of the relief devices, that could be attained with internal arc fault.

6.12.3 All gas seals shall be designed to ensure that leakage rates are kept to specified minimum under all pressure, temperature, electrical load and fault conditions.

## 6.13 Voltage Detectors (applicable for 220 kV and above)

Each outgoing & incoming bays and main bus bars shall include capacitive type voltage detectors for each phase to indicate phases "ALIVE". The unit shall also be suitable for interlocking of earthing switches (voltage free condition).

## 6.14 Outdoor SF<sub>6</sub> – Air Bushings

6.14.1 Outdoor SF<sub>6</sub> – Air bushings, for the connection of conventional external conductors to the GIS shall generally be in accordance with the requirements of IEC 60137 as applicable.

6.14.2 Bushing type shall be any of the following:

- a) Condenser type bushings, liquid filled with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will be accepted if specifically approved.
- b) The bushings with composite insulators (Silicone rubber) or with porcelain insulators with all surfaces free from imperfections. The internal insulation of the bushings shall be resin impregnated paper winding (RIP body) or compressed SF<sub>6</sub> gas. The internal and external electrical field of the bushings shall be controlled by a capacitive grading body /grading shields. The RIP body shall consist of resin impregnated paper insulation with concentric aluminium layers. The space between the RIP body and the insulator shall be filled with insulating foam compound or compressed SF<sub>6</sub> gas. Air bushings shall comply with the relevant IEC standards.

6.14.3 Bushings shall be designed to have ample mechanical strength and rigidity for the conditions under which they will be used. Outdoor bushings shall be capable of withstanding a cantilever force applied to the terminal.

6.14.4 All current carrying parts shall be of Copper. Hardware used for current carrying parts (such as nuts, bolts etc.) shall be SS304 Grade or brass. All current carrying contact surfaces shall be silver faced.

6.14.5 The flange shall be made of weather resistant, corrosion proof material. Suitable arrangement for connection of flange to earth shall be provided. If required, corona ring shall be provided which will be of Copper / Brass.

6.14.6 Porcelain shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects.

6.14.7 The parameters characterising the SF<sub>6</sub>- Air bushing profile shall be such that it is suitable for "Very heavy" pollution level (salt contamination) prevailing at the site and also suitable for fixed type hot line washing. The creepage distance over the external surface of outdoor bushings shall not be less than 31 mm/kV.

6.14.8 Puncture strength of bushings shall be greater than the dry flash-over value. When operating at normal rated voltage, there shall be no electric discharge between the conductors and bushing which would cause corrosion / erosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action.

6.14.9 All joints shall be air-tight. Surface of the joints shall be trued-up; porcelain parts by grinding and metal parts by machining. Bushing design shall be so as to ensure uniform compressive pressure on the joints.

## 6.15 Gas Insulated Bus Duct

6.15.1 The Gas insulated bus duct shall be 3-phase enclosure or single phase enclosure as per vendor standard design comprising of straight lengths, bends, elbows, gas seals and accessories such as flanges, gaskets, fixing hardware etc.

6.15.2 Bus bars shall be of high conductivity electrolytic aluminium or copper.

6.15.3 The enclosure for the bus duct shall be made from non-magnetic material e.g., AL/AL Alloy.

- 6.15.4 The bus duct shall be capable to withstand the mechanical and thermal stresses due to short circuit currents, as well as thermal expansion and contraction created by temperature cycling.
- 6.15.5 The bus duct shall be suitable for outdoor installation.
- 6.15.6 The bus duct shall not be supported from the wall when crossing from indoor to outdoor. Necessary accessories supports etc. including wall frame assemblies shall form part of supply. Necessary bellows (if required) with sealing arrangements shall be provided.

## 7.0 INSPECTION, TESTING AND ACCEPTANCE

- 7.1 Vendor shall have valid type test certificates to verify the making and breaking capacity of the switching devices & other primary components and other test certificates as per relevant IEC standards.
- 7.2 During fabrication, the switchgear shall be subjected to inspection by EIL / Owner or by an agency authorised by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The vendor shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.
- 7.3 All switchgear components (CBs, disconnectors, earthing switches etc) shall be tested in accordance with the latest relevant standards. Test certificates for each switchgear component shall be submitted prior to delivery.
- 7.4 Type test certificates / reports shall be considered acceptable if they are in compliance with the latest applicable relevant Standards and conducted at recognized laboratory. If the type test reports submitted are not in accordance with the above requirements, Owner/EIL reserves the right to ask for the type tests to be repeated in the vendor's premises or other recognized place. The recognized laboratory shall issue the relevant type test certificates upon successful testing.
- 7.5 Switchgears and their components shall be subjected to routine tests as per the relevant IEC standards. Routine test certificates shall be submitted for EIL/Owner's review and approval before shipment of the switchgear components. The routine tests for the switchgear shall also include the functional tests for the associated LCC & CRP.
- 7.6 For testing requirements, refer Inspection & Test Plan Spec no. 6-81-1066.

## 8.0 PACKING AND DESPATCH

- 8.1 The equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage.
- 8.2 The SF<sub>6</sub> equipment shall be shipped in the largest factory assembled units within transport and loading limitations and considering handling facilities on site to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

- 8.3 Each individual piece to be shipped, whether crate, container or large unit, shall be marked special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., and other details as per purchase order.
- 8.4 The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains and high ambient temperature. In order to prevent movement of equipment within the crates, proper packing supports shall be provided.
- 8.5 Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF<sub>6</sub> gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.
- 8.6 All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided. All parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected. Any seals, gaskets, 'O' rings, etc. that will be used as part of the arrangement for sealing off gas sections for shipment to site shall not be used in the final installation of equipment at site. Vendor to provide quantity of components accordingly considering permanent installation.
- 8.7 Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings.
- 8.8 A set of instruction manuals for erection, testing and commissioning, a set of operating & maintenance manuals and a set of final drawings shall be enclosed in a waterproof cover and supplied along with the shipment.

# ENGINEERING DESIGN BASIS ELECTRICAL

JOB NO: **B269**  
PROJECT: **PANIPAT REFINERY EXPANSION (P-25) PROJECT**  
CLIENT: **INDIAN OIL CORPORATION LIMITED (IOCL)**

EIL SIGNATURE:

CLIENT SIGNATURE:



|                 |             |   |                            |                    |                    |
|-----------------|-------------|---|----------------------------|--------------------|--------------------|
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| <b>Rev. No.</b> | <b>Date</b> | <b>Purpose</b>  | <b>Prepared by</b>         | <b>Reviewed by</b> | <b>Approved by</b> |

Legend: ***Bold italic*** text denotes change with respect to previous revision.

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## 1.0 SCOPE

This electrical design basis defines the design requirements agreed by owner/clients in addition to EIL standard design philosophy for electrical facilities no. 6-51-0099. In case of any conflict between statutory requirements, this design basis and standard design philosophy, the most stringent requirement shall govern.

## 2.0 ABBREVIATIONS, CODES & STANDARDS / PUBLICATIONS

### 2.1 ABBREVIATIONS

| Code  | Description                                |
|-------|--|
| AC    | Alternating Current                        |
| ACB   | Air Circuit Breaker                        |
| APFC  | Automatic Power Factor Correction          |
| ASB   | Auxiliary Service Board                    |
| ATS   | Auto Transfer Scheme                       |
| CB    | Circuit Breaker                            |
| CBCT  | Core Balance Current Transformer           |
| CEA   | Central Electricity Authority              |
| CT    | Current Transformer                        |
| DC    | Direct Current                             |
| DCP   | Data Concentrator Panel                    |
| DG    | Diesel Generator                           |
| DGMS  | Director General Mines Safety              |
| DOL   | Direct On Line                             |
| EHV   | Extra High Voltage                         |
| ELCB  | Earth Leakage Circuit Breaker              |
| DMPR  | Digital Motor Protection Relay             |
| EPC   | Emergency Power Control Center             |
| EPMCC | Emergency Power cum Motor Control Center   |
| FBT   | Fast Bus Transfer                          |
| FRLS  | Flame Retardent Low Smoke                  |
| FS    | Fire Survival                              |
| GI    | Galvanised Iron                            |
| GIBD  | Gas Insulated Bus Duct                     |
| GIS   | Gas Insulated Switchboards                 |
| GTG   | Gas Turbine Generator                      |
| HMI   | Human Machine Interface                    |
| HSR   | High Availability Seamless Redundancy      |
| HV    | High Voltage                               |
| IEC   | International Electro-Technical Commission |
| LDB   | Lighting Distribution Board                |
| LV    | Low Voltage                                |
| MCC   | Motor Control Centre                       |
| MCCB  | Moulded Case Circuit Breaker               |
| MOV   | Motor Operated Valve                       |
| MPCB  | Motor Protection Circuit Breaker           |
| MV    | Medium Voltage                             |
| NA    | Not Applicable                             |
| NGR   | Neutral Grounding Resistor                 |
| NGT   | Neutral Grounding Transformer              |
| OLTC  | On Load Tap Changer                        |

| Code | Description                               |
|------|---|
| PCC  | Power Control Centre                      |
| PESO | Petroleum & Explosive Safety Organisation |
| PLC  | Programmable Logic Control                |
| PMCC | Power Cum Motor Control Centre            |
| PRP  | Parallel Redundancy Protocol              |
| PT   | Potential Transformer                     |
| PTB  | Physikalisch-Technische Bundesanstalt     |
| PVC  | Polyvinyl Chloride                        |
| RCC  | Reinforce Cement Concrete                 |
| RSTP | Rapid Spanning Tree Protocol              |
| SAS  | Substation Automation System              |
| SFU  | Switch Fuse Unit                          |
| SPN  | Single Phase & Neutral                    |
| SPV  | Solar Photo Voltic                        |
| STG  | Steam Turbine Generator                   |
| TP   | Three Phase                               |
| TPN  | Three Phase & Neutral                     |
| UPS  | Uninterrupted Power Supply                |
| VCB  | Vacuum Circuit Breaker                    |
| VFD  | Variable Frequency Drive                  |
| XLPE | Cross Link Poly Ethylene                  |

## 2.2 CODES & STANDARDS / PUBLICATIONS

The main codes and standards, considered as minimum requirements, as applicable, are as follows -

| S.No. | Description   | Standards / Codes | Edition |
|-------|---|-------------------|---------|
| 1     | Code of practice for the fire safety of buildings - Electrical Installations.                               | IS-1646           | Latest  |
| 2     | Code of practice for selection: installation and maintenance of automatic fire detection and alarm system.  | IS-2189           | Latest  |
| 3     | Code of practice for the protection of buildings and allied structures against lightning.                   | IS/IEC-62305      | Latest  |
| 4     | Code of practice for fire safety of industrial buildings - Electrical generating and distributing stations. | IS-3034           | Latest  |
| 5     | Code of practice for Earthing.  | IS-3043           | Latest  |
| 6     | Code of practice for Interior Illumination.   | IS-3646           | Latest  |
| 7     | Application guide for Insulation Coordination.  | IS-3716           | Latest  |
| 8     | Code of practice for installation and maintenance of electrical equipment in mines                          | IS-4051           | Latest  |
| 9     | Guide for safety procedures and practices in electrical work  | IS-5216           | Latest  |
| 10    | Guide for selection of electrical equipment for hazardous areas.  | IS-16724          | Latest  |

| S.No. | Description  | Standards / Codes | Edition |
|-------|--|-------------------|---------|
| 11    | Classification of hazardous areas(other than mines) having flammable gases and vapours for electrical installations.                   | IS-5572           | Latest  |
| 12    | Code of practice for Industrial Lighting.  | IS-6665           | Latest  |
| 13    | Guide for Control of undesirable static electricity.   | IS-7689           | Latest  |
| 14    | Guide for improvement of power factor - consumer's installations.  | IS-7752           | Latest  |
| 15    | Application guide for on load tap changers.  | IS-8478           | Latest  |
| 16    | Reference ambient temperature for electrical equipment   | IS-9676           | Latest  |
| 17    | Code of practice for selection, installation and maintenance of transformer.   | IS-10028          | Latest  |
| 18    | Code of practice for selection, installation and maintenance for switchgear and control gear.  | IS-10118          | Latest  |
| 19    | Application guide for Power Transformer.   | IS-10561          | Latest  |
| 20    | Voltage bands for electrical installations including preferred voltages and frequencies.   | IS-12360          | Latest  |
| 21    | Guide for short circuit calculations in three phase AC systems.  | IS-13234          | Latest  |
| 22    | Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres. | IS-13408(Part-1)  | Latest  |
| 23    | Guide to the use of electrical apparatus for potentially explosive atmospheres in the presence of combustible dusts                    | IS- 15142         | Latest  |
| 24    | National Electrical Code (NEC) - BIS Publication.  | SP-30             | Latest  |
| 25    | Recommended practices on static electricity  | OISD-STD-110      | Latest  |
| 26    | Classification of Area for electrical installation at Hydrocarbon Processing and handling facilities                                   | OISD STD-113      | Latest  |
| 27    | Inspection and safe practices during electrical installation   | OISD-STD-147      | Latest  |
| 28    | Design aspects for safety in electrical systems  | OISD STD-149      | Latest  |
| 29    | Fire Protection System for Electrical Installations  | OISD STD 173      | Latest  |
| 30    | Lightning Protection   | OISD STD-180      | Latest  |
| 31    | Electrical apparatus for explosive gas atmospheres - General requirements.   | IS/IEC 60079-0    | Latest  |

| S.No. | Description  | Standards / Codes       | Edition |
|-------|--|-------------------------|---------|
| 32    | Equipment protection flameproof enclosures "d"   | IS/IEC 60079-1          | Latest  |
| 33    | Electrical apparatus for explosive gas atmospheres - Intrinsic safety "i"  | IS/IEC 60079-11         | Latest  |
| 34    | Electrical apparatus for explosive gas atmospheres Increased safety type "e"   | IS/IEC 60079-7          | Latest  |
| 35    | Electrical apparatus for explosive gas atmospheres - Oil immersion "o"   | IS/IEC 60079-6          | Latest  |
| 36    | Electrical Apparatus for explosive gas atmospheres - Powder filling "q"  | IS/IEC 60079-5          | Latest  |
| 37    | Material characteristics for gas and vapour classification - section 1 - Test methods and data.  | IS/IEC 60079-20-1       | Latest  |
| 39    | Energy Efficient induction motors- Three phase squirrel cage   | IS 12615                | Lateat  |
| 40    | Outdoor Type Oil Immersed Distribution Transformers Upto and including 2500 kVA, 33kV  | IS 1180                 | Latest  |
| 41    | Electrical apparatus for use in the presence of combustible dust : General Requirements  | IS/IEC 60079-31         | Latest  |
| 42    | Electrical apparatus for use in the presence of combustible dust : Classification of areas where combustible dusts are or may be present | IS/IEC 60079-31         | Latest  |
| 43    | Electrical apparatus for use in the presence of combustible dust : Selection and installation  | IS 16724 & IEC 60079-14 | Latest  |
| 44    | Explosive atmospheres - Equipment protection by type of protection "n"   | IEC 60079-15            | Latest  |
| 45    | IEEE recommended practice and requirements for harmonic control in electric power systems  | IEEE-519                | Latest  |

### 3.0 GENERAL / DESIGN CONSIDERATIONS

| S.No. | Project Philosophy   |
|-------|--|
| 1     | LV - Low Voltage. The voltage which does not normally exceeds 250 V.                         |
| 2     | MV - Medium Voltage. The voltage which normally exceeds 250 V and does not exceeds 650 V.    |
| 3     | HV - High Voltage. The voltage which normally exceeds 650 V but does not exceed 33 kV.       |
| 4     | EHV - Extra High Voltage. The voltage which exceeds 33 kV under normal condition.            |
| 5     | Canopy shall be provided for all outdoor equipments except transformers and Capacitor Banks. |

| S.No. | Project Philosophy  |
|-------|---|
| 6     | Circuit breaker provided for PCC/EPCC/MCC Incomer & Buscoupler shall be of 4 Pole type. |

#### 4.0 SPECIFIC DESIGN REQUIREMENTS

| S.No. | Project Philosophy  |
|-------|---|
| 1     | Spare capacity of exchange of new PA System shall be considered as 30%.   |
| 2     | Each DGFAP panel and each loop shall have 30% spare capacity.   |
| 3     | Transformers and Switchboards shall have 20% spare capacity.  |
| 4     | DC system shall have 25% spare capacity for future load growth and DCDB shall have 20% spare feeders.   |
| 5     | UPS system shall have 20% spare capacity for future load growth and ACDB shall have 20% spare feeders.  |
| 6     | Separate DC systems shall be provided for switchgear protection and critical lighting   |
| 7     | UPS ACDB shall be with two incomers and one buscoupler.   |
| 8     | DCDB shall be provided with two incomers and one bus coupler.   |
| 9     | Incomers and buscoupler of MCC shall be provided with ACB and numerical relays with auto-changeover facility.   |
| 10    | Dummy panel shall be provided in switchboards where switchboard is located over the expansion joint in substation building.   |
| 11    | Window type CT shall be provided in HV switchboards for CT Primary rating more than 150A.   |
| 12    | HV switchboards shall be provided with thermography window for infrared electrical inspection.  |
| 13    | All HV Switchgear shall be provided with online wireless temperature monitoring facility. The passive sensor should be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It should take direct measurement on critical point. This facility shall be interfaced with ECS.   |
| 14    | All large capacity motors/feeders in MV Switchgear shall be provided with online wireless temperature monitoring facility. The passive sensor should be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It should take direct measurement on critical point. This facility shall be interfaced with ECS.  |
| 15    | All contacts used for breaker status (ON/OFF/SERVICE) shall be independent of availability of DC supply.  |
| 16    | Transformers rated above 2.5 MVA shall be provided with air bag for conservators.   |
| 17    | In general the rating of distribution transformers shall be standardised to 2500kVA except for cases where power requirements are very small  |
| 18    | OLTC with RTCC facility shall be provided for main power transformers (66/6.9kV) and (33/6.9kV) only.   |
| 19    | In every outdoor transformer bay/yard one no. 100A outlet shall be provided for oil filtration and other maintenance requirements.  |
| 20    | Road crossings<br>a) Road crossings where large number of cables cross the roads, shall be provided using Cable culverts. At road crossings where few cables cross the roads, Electrical road crossings (ERC) using 150mm PVC/RCC pipes may be provided. The ERC shall have minimum 30% spare pipes. The pipes shall be embedded in concrete.<br>b) Minimum 6 nos. 150mm pipes shall be provided in ERC at any road crossing. |
| 21    | Flooring of substation switchgear hall shall be painted with insulating paint. Rubber mats shall also be provided around switchboards as per CEA safety regulations   |
| 22    | Cable cellar floor shall be raised 500mm above approach road level.   |

| S.No. | Project Philosophy   |
|-------|--|
| 23    | In all Substations/ MCC rooms, space for future extension of all GIS, HV Switchboards, PCCs, MCCs and ASBs shall be provided. Minimum space for two vertical panel extension on each side (for each Bus section) or four vertical panel extension space on one side (in exceptional cases) shall be provided.  |
| 24    | MV motors for safe & hazardous area shall be IE3 as per IS 12615:2011.   |
| 25    | For each sync. Motor 2 Nos ON status signals shall be provided from the Switchboard to Excitor panel for the motor.  |
| 26    | For all HV Motors, RTD/BTD output shall be taken directly to DCS. DCS shall have provision for data logging, trending and generation of trip command based on input received from these motor based RTD/BTD.   |
| 27    | Redundancy with dual excitation channel along with redundant PLC shall be provided for excitor where single sync. drive process equipment without any standby equipment is provided.   |
| 28    | For sync. motors redundant UPS control supply and redundant UPS supply or PMG based supply for excitation system shall be provided. Also AI (4-20mA) to ECS for excitation current monitoring shall be provided  |
| 29    | All monitoring signals from substation to SRR/Control room for critical inputs related to process control shall be hardwired to DCS/PLC. Other feedbacks to DCS which are used only for indication shall be routed through ECS panels over serial link. All control signals shall be as per instrumentation philosophy.                                |
| 30    | For all plant feeders, following signal exchange shall be done through OFC cable being used for feeder differential protection, in place of Cu cable connectivity :<br>a.) Inter-trip command to remote substation<br>b.) Breaker Status from upstream to downstream & vice-versa.<br>c.) Close per missives from upstream to downstream & vice-versa. |
| 31    | Intertrip signals between interconnected switchboards within a substation shall be hardwired along with parallel operation through GOOSE messaging.  |
| 32    | Auto-changeover logic to be built in the numerical relays of HV & MV switchboards shall use hardwired inputs to/ from the relays. Additionally parallel logic using GOOSE messaging shall also be used for Auto changeover logic in HV & MV switchboards.  |
| 33    | Terminals for all spare cores of instrument interface cables shall be considered while sizing the number of terminals in the common substation marshalling panel.  |
| 34    | Each process unit shall be provided with minimum 5nos. 3 phase, 4 wire, 415V, 400A flameproof (Ex-d) power supply DB for hydro-jetting and other miscellaneous utilities   |
| 35    | All Emergency Stop/Stop pushbuttons on LCS/LCP/Switchboard shall be provided with protective covers to avoid accidental operation  |
| 36    | 63A Welding receptacles shall be provided in 30m radius with provision of same on alternate floor of tech structures.  |
| 37    | Fixed type 240/24V sealed transformer units with plug sockets shall be provided near manholes of column and vessels.   |
| 38    | Dual pushbutton stations with logic to press both for transformer trip shall be provided in the transformer bays. Push buttons shall be provided with covers.  |
| 39    | All Cards shall be provided with G3 conformal coating for numerical relays, UPS & VFDs at all location.  |
| 40    | All safe area pushbutton station shall be of polycarbonate or similar metallurgy.  |
| 41    | HV & MV Switchboard shall not be provided with marshalling panels in panel lineup. Each substation shall have standalone floor mounted marshalling panels separate for ECS & DCS interface.  |
| 42    | 220kV, 66kV Switchboards shall be suitable for short circuit withstand capacity for 3 Secs   |

| S.No. | Project Philosophy  |
|-------|---|
| 43    | <p>An independent ECS system may be provided for P-25 system complete in all respect along with following provisions.</p> <p>a) One Gate way terminal on OPC protocol with hardwired I/Os (60 digital Input, 30 Analogue input, 60 digital output &amp; 30 Analogue output) shall be provided for PR side future integration.</p> <p>b) One Gate way terminal on OPC protocol with hardwired I/Os (60 digital Input, 30 Analogue input, 60 digital output &amp; 30 Analogue output) shall be provided for PNCP side future integration.</p>   |
| 44    | <p>Equipment numbering philosophy for electrical equipment in refinery area shall be as listed below (@@@ - denotes substation number) :</p> <p>220/69kV Power Trafo : TR-@@@011<br/> 66/11kV Power Trafo : TR-@@@021<br/> 66/6.9kV Power Trafo : TR-@@@031<br/> 6.6/0.433kV Dist Trafo : TR-@@@041<br/> 415/415V Normal/Emg. Ltg Trafo : TR-@@@061<br/> 220kV GIS Isolator : HV-@@@101<br/> 66kV GIS : HV-@@@111<br/> 6.6kV Switchboard : HV-@@@201<br/> 415V Normal/Emg. Power : PCC-@@@301<br/> 415V Normal/Emg. Power MCC : MCC-@@@311<br/> 415V Normal/Emg. Lighting : LB-@@@331<br/> 415V Aux. Power : ASB-@@@351<br/> Normal Lighting Panel : LP-@@@501<br/> Emg. Lighting Panel : ELP-@@@531<br/> Power Panels : PP-@@@601<br/> Space Heater Panels : SHP-@@@631<br/> Power Panels for instrumentation : PPI-@@@661<br/> 110V DCDB : DCDB-@@@701<br/> 110V UPD : ACDB-@@@711<br/> ECS Panels : IFP/IRP-@@@901<br/> Marshalling Panels : DCSMB/ECSMB-@@@911<br/> Tag number indicated above is for the first equipment in the series of that type.</p> |
| 45    | <p>Substation number for new PPU in PNCP shall be SS-62 and equipment numbering philosophy for electrical equipment shall be as listed below</p> <p>Type : Tag<br/> 11kV : HV-6222<br/> 33/6.9kV Power Trafo : TR-6201/02/03--<br/> 6.6/0.433kV Dist Trafo : TR-6211/12/13--<br/> 415/415V Normal/Emg. Ltg Trafo : TR-6261/62--<br/> 6.6kV Switchboard : HV-6221<br/> 415V Normal/Emg. Power : PCC-6231/32--<br/> 415V Normal/Emg. Power MCC : MCC-6241/42--<br/> 415V Normal/Emg. Lighting : LDB-6252/53--<br/> 415V Aux. Power : ASB-6251<br/> 110V DCDB : DCDB-6271<br/> 110V UPD : ACDB-6275</p> <p>Tag number of any other switchboard in addition to above shall be provided in similar lines.</p>  |
| 46    | Refer Annexure-1 for typical configuration for DC System.   |
| 47    | Refer Annexure-2 for typical configuration for UPS System.  |
| 48    | Refer Annexure-3 for typical block diagram for ECS System in Substation.  |

| S.No. | Project Philosophy   |
|-------|--|
| 49    | Refer Annexure-4 for typical scheme for Auto-change over scheme for DC control supply to switchboards. |

## 5.0 OWNER / CLIENT SPECIFIC REQUIREMENTS

### 5.1 SITE CONDITIONS

| S.No. | Description                             | Selected Option                  | Available Options |
|-------|---|----------------------------------|-------------------|
| 1     | Equipment design temperature (IS-9676)  | 45 DEG C                         |                   |
| 2     | Relative humidity                       | 90%                              |                   |
| 3     | Soil Resistivity                        | As per soil investigation report |                   |
| 4     | Minimum temperature. for battery sizing | 5 DEG C                          |                   |
| 5     | Altitude above mean sea level           | Less than 1000m above MSL        |                   |
| 6     | Maximum temp                            | 50 DEG C                         |                   |
| 7     | Minimum temp                            | 5 DEG C                          |                   |
| 8     | Siesmic Zone                            | Refer Structural Design Basis    |                   |

Notes :

- 1.) Minimum temperature to be considered for electrical heat tracing shall be 5 DEG. C
- 2.) Pollution level for all outdoor electrical equipments shall be considered as "Heavy"

### 5.2 POWER SOURCE DETAILS

| S.No. | Description                         | Selected Option            | Available Options |
|-------|-------------------------------------|----------------------------|-------------------|
| 1     | Power System                        | From Existing & New System |                   |
| 2     | Grid Supply                         |                            |                   |
| 2.1   | Name of sub station                 | Mundh                      |                   |
| 2.2   | Number of feeders                   | 2 Nos                      |                   |
| 2.3   | Length of feeder                    | 35km                       |                   |
| 2.4   | Type /size of conductor/ cable size | ACSR / ZEBRA CONDUCTOR     |                   |
| 2.5   | Voltage                             | 220kV $\pm$ 10 %           |                   |
| 2.6   | Frequency                           | 50Hz $\pm$ 3 %             |                   |
| 2.7   | Maximum fault level                 |                            |                   |
| 2.7.1 | 3 Phase fault                       | 50 kA, 3 sec               |                   |
| 2.7.2 | 1 Phase fault                       | \$ kA, sec                 |                   |
| 2.7.3 | X/R Ratio                           | \$                         |                   |
| 2.8   | Minimum fault level                 | \$ kA, sec                 |                   |
| 2.9   | Design fault level                  | \$ kA, Sec                 |                   |
| 2.10  | Basic Insulation Level              | \$ kV                      |                   |
| 2.11  | System neutral Earthing             | Solidly Earthed            |                   |
| 2.12  | Minimum power factor                | \$                         |                   |
| 2.13  | Parallel operation of incomers      | \$                         |                   |
| 2.14  | PLCC requirement                    | \$                         |                   |

| S.No. | Description   | Selected Option  | Available Options                               |
|-------|---|--|---|
| 3     | CPP and its configuration                           |  | Not envisaged<br>(below clauses not applicable) |
| 3.1   | Type of Generator                                   |  |   |
| 3.1.1 | Number of Generator                                 |  |   |
| 3.1.2 | Rating of Generator/Voltage/P.f                     |  |   |
| 3.1.3 | Requirement of Generator Circuit Breaker            |  |   |
| 3.2   | Parallel operation with grid                        |  |   |
| 3.3   | Type of Neutral Earthing for Generators             |  |   |
| 3.4   | Black Start DG Envisaged                            |  |   |
| 4     | Emergency generator                                 | @ Centralised  |   |
| 4.1   | Generator Voltage                                   | @ kV   |   |
| 4.2   | Parallel operation with other sources               | Momentary Paralleling  |   |
| 4.3   | Auto Starting                                       | Yes  |   |
| 4.4   | Type of Emergency Generator                         | Diesel   |   |
| 5     | Solar Power System                                  |  |   |
| 5.1   | Solar PV System                                     | \$ Provided  |   |
| 5.2   | Buildings on which solar power system to be mounted | Non Plant Buildings, Admin Building, Warehouse, Substations, Safe area Control Rooms |   |
| 5.3   | Technology  | Silicon Crystalline (Mono/Poly)  |   |
| 5.4   | Battery   | Not provided   |   |
| 5.5   | Connectivity  | Local Switchboard  |   |
| 5.6   | Monitoring System                                   | ModBus serial link with ECS for data logging/Monitoring.                             |   |
| 5.7   | Location of Inverter                                | Installed in switchgear hall either floor or wall mounted                            |   |

Notes:-

\$- data to be provided/ confirmed by Client.

@- details to be finalised during detail engineering.

Details provided above is for existing grid supply. Details for new grid supply shall be provided by client

### 5.3 POWER SUPPLY DISTRIBUTION SYSTEM

#### 5.3.1 VOLTAGE AND FREQUENCY VARIATION

| S.No. | Description | Selected Option                                | Available Options |
|-------|-------------|--|-------------------|
| 1     | AC System   |  |                   |
| 1.1   | Voltage     | 220kV/66kV/33kV/6.6kV/415V ± 10%<br>(Note-1&5) |                   |
| 1.2   | Frequency   | 50 Hz ± 3%                                     |                   |
| 2     | DC System   |  |                   |

| S.No. | Description                              | Selected Option                    | Available Options |
|-------|--|------------------------------------|-------------------|
| 2.1   | Electrical protection and Control system | 110V +15%/-10% (Refer Note-4)      |                   |
| 2.2   | DC critical Lighting system              | 220V +15%/-10%                     |                   |
| 2.3   | Instrumentation Power Supplies           | Refer Instrumentation Design Basis |                   |

Note:-

\$- data to be provided/ confirmed by Client.

- 1.) Voltage variation for 220kV shall be as per grid norms.
- 2.) Separate DC systems for lighting and protection & control to be provided in substation.
- 3.) Refer section 5.6.10 of this document for design voltage/frequency variation for motors.
- 4.) For PNCP, 220V DC System shall be considered for electrical protection & control system.
- 5.) 66kV shall be considered for primary power distribution in P-25 facilities on the refinery side. 33kV shall be considered for primary power distribution for new PPU in PNCP based on existing philosophy.

### 5.3.2 UTILISATION VOLTAGE

| S.No. | Description   | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 1     | Primary EHV/HV distribution voltage                 | 220kV/66kV/33kV (Refer to note-3)  |                   |
| 2     | Secondary HV distribution voltage                   | 6.6kV  |                   |
| 3     | Primary EHV/HV distribution system neutral Earthing | Solidly Earthed  |                   |
| 4     | Secondary HV distribution system Neutral Earthing   | NGR  |                   |
| 5     | HV motor voltage for DOL                            | 6.6kV (For motors rating > 160kW)  |                   |
| 6     | MV motor voltage                                    | 415 V AC (except VFD motor without bypass) (For motors rating 0.18<=kW<=160) |                   |
| 7     | AC Motors   | 240V AC (except MOVs) (For motors rating < 0.18kW)                           |                   |
| 8     | DC Motor  | As per equipment supplier standard   |                   |
| 9     | Motor operated valves                               | 415V AC, TP  |                   |
| 10    | Battery chargers incoming power supply              | 415V AC,TPN  |                   |
| 11    | UPS System incoming power supply                    | 415V AC,TPN  |                   |
| 12    | AC Lighting/Power Panels                            | 415V AC,TPN  |                   |
| 13    | Auxiliary Boards incoming power supply              | 415V AC,TPN  |                   |
| 14    | Welding Receptacles                                 | 415V AC,TPN  |                   |
| 15    | Bulk loads like Process Heaters etc                 | 415V AC,TP   |                   |
| 16    | Normal Lighting/Emergency Lighting                  | 240V AC,SPN  |                   |

| S.No. | Description | Selected Option | Available Options |
|-------|-------------|-----------------|-------------------|
| 17    | LAN UPS     | 240V AC, SPN    |                   |

Notes :

- 1.) Input power supply for VFDs upto 315kW without bypass shall be 415V AC and for VFDs above 315kW shall be 6.6kV AC. However power supply for VFDs with bypass shall be 415V upto 160kW and 6.6kV for VFDs above 160kW.
- 2.) Power supply for Air-conditioning for Control Rooms / Satellite Rack Rooms shall be taken from normal supply.
- 3.) 66kV shall be considered for primary power distribution in P-25 facilities on the refinery side. 33kV shall be considered for primary power distribution for new PPU in PNCP based on existing philosophy.

### 5.3.3 UTILISATION VOLTAGE FOR CRITICAL SUPPLIES

| S.No. | Description                                       | Selected Option   | Available Options |
|-------|---|---|-------------------|
| 1     | Switchgear protection control power supply        | 110V DC<br>220V DC for PNCP PPU<br>(Note-1)                                     |                   |
| 2     | Critical lighting power supply                    | 220V DC<br>(Note-2)   |                   |
| 3     | Input power supply for Plant communication system | 110V AC UPS   |                   |
| 4     | Input power supply Fire alarm system power supply | 240V AC UPS SPN<br>(DGFAP/CFAP/RP to be provided with Dedicated battery backup) |                   |
| 5     | Power supply for electrical annunciation panel    | NA (Part of SAS HMI)  |                   |
| 6     | Normal Instrumentation power supply               | Refer Instrumentation design basis  |                   |
| 7     | Critical instrumentation power supply             | Refer Instrumentation design basis  |                   |
| 8     | Instrumentation Shut-down system power supply     | Refer Instrumentation design basis  |                   |

### 5.3.4 OPERATING PHILOSOPHY

| S.No. | Description   | Selected Option                  | Available Options |
|-------|---|----------------------------------|-------------------|
| 1     | Auto/Manual transfer at primary distribution voltage bus with momentary paralleling   | No                               |                   |
| 2     | Auto/Manual transfer at secondary distribution voltage bus with momentary paralleling | Yes (FBT on 6.6kV Bus)           |                   |
| 3     | Auto /Manual transfer at MV with momentary paralleling                                |                                  |                   |
| 3.1   | At PCC/EPC/EPMCC Level  | Yes                              |                   |
| 3.2   | At MCC/ASB/LDB Level  | Yes- MCC (Note-1)<br>No- ASB/LDB |                   |

| S.No. | Description  | Selected Option   | Available Options |
|-------|--|---|-------------------|
| 4     | Continuous Parallel operation of Incomers            |   |                   |
| 4.1   | Primary EHV/HV voltage                               | 220kV & 66kV & 33kV   |                   |
| 4.2   | Secondary HV voltage                                 | No  |                   |
| 4.3   | PCC/PMCC   | No  |                   |
| 5     | Power Factor Correction                              | Required (through local APFC Panel)   |                   |
| 5.1   | Power factor improvement capacitors- location        | 6.6kV bus   |                   |
| 5.2   | Minimum P.F. to be maintained at Transformer Primary | 0.95<br>(at primary of power transformers of respective substation)                           |                   |
| 5.3   | Monitoring at Transformer Primary                    | Yes   |                   |
| 6     | Load shedding  | Yes   |                   |
| 6.1   | Voltage level for Load Shedding                      | All 6.6kV and incomers, buscoupler & outgoing breaker power/motor feeders for PCC at 0.415kV. |                   |

Note:-

1.) Only for MCCs for process units. Not applicable for package MCCs e.g. A/C, Pressurisation etc., however same shall be provided with 2 Incomers with mechanical interlock.

## 5.4 CONTROL-PROTECTION - METERING

### 5.4.1 CONTROL PHILOSOPHY

| S.No. | Description   | Selected Option   | Available Options |
|-------|---|---|-------------------|
| 1     | Location of Relays for Generator                    | NA  |                   |
| 2     | Location of Relays for Outdoor Switchyard           | NA  |                   |
| 3     | Location of Protection relays for EHV/HV switchgear |   |                   |
| 3.1   | Primary voltage EHV/HV switch gear                  | On CRP for EHV GIS<br>On switchgear for others                          |                   |
| 3.2   | Secondary Voltage HV switchgear                     | On switchgear   |                   |
| 4     | EHV/HV Switchgear control                           |   |                   |
| 4.1   | Generator   | NA  |                   |
| 4.2   | Outdoor Switchyard                                  | NA  |                   |
| 4.3   | Primary voltage EHV/HV switch gear                  | On switchgear & ECS   |                   |
| 4.4   | Secondary Voltage HV switchgear                     | On switchgear & ECS for all feeders except motor feeder. (refer Note-2) |                   |
| 5     | Numerical Protection/Monitoring system for          |   |                   |
| 5.1   | EHV system  | Yes   |                   |

| S.No. | Description                                   | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 5.2   | HV Switchboard                                | Yes  |                   |
| 5.3   | PMCC/PCC                                      | Yes  |                   |
| 5.4   | MCC   | Yes (only for incomers and Bus Coupler)  |                   |
| 6     | Control and logic through numerical relays    | Yes  |                   |
| 7     | Hardwired synchronization control panel-SCAP  | NA   |                   |
| 7.1   | Synchronizing trolley required                | NA   |                   |
| 7.2   | Type of Panel                                 | NA   |                   |
| 7.3   | Extent of Coverage on SCAP                    | NA   |                   |
| 8     | Type of annunciation panel                    | HMI  |                   |
| 9     | Load shedding panel                           | Power contingency load shedding shall be part of ECS System<br>Frequency based load shedding shall be provided in each substation. |                   |
| 10    | Method of motor starting                      |  |                   |
| 10.1  | HV Motors                                     | Direct on line (For motor rated upto 2MW)  |                   |
| 10.2  | HV Motors                                     | Refer Note 1 below   |                   |
| 10.3  | MV Motors                                     | DOL up to motor rating 160kW (VFD if required as per process requirement)  |                   |
| 11    | Starting MVA limitation conditions for Motors |  |                   |
| 11.1  | HV Motors                                     | To be decided during detailed engg.  |                   |
| 11.2  | MV Motors                                     | As per std specifications (values in IS 12615:2011 + IS/IEC tolerance)   |                   |

Notes:

- 1.) Dedicated transformer/ V/F controlled soft starter shall be considered for starting large HV motors if essential/unavoidable as per system design requirement/equipment design limitation based on the electrical system study.
- 2.) All incomers, buscouplers & outgoing transformer feeders shall be provided with Local/ECS selector switch. Close from ECS shall be provided through this selector switch. In case of Incomers & buscouplers, close control from ECS shall be for manual dead-bus or momentary parallel close conditions only. Auto changeover logic shall be provided in switchboard only and same shall operate in the "Local" position of Local/ECS selector switch provided on incomer/buscoupler.

**5.4.2 POWER ISOLATION FOR TRANSFORMERS LOCATED REMOTELY AWAY FROM HV SUBSTATION**

| S.No. | Description  | Selected Option | Available Options |
|-------|--|-----------------|-------------------|
| 1     | Push button in transformer bay for tripping remote breaker | Yes             |                   |

| S.No. | Description                  | Selected Option | Available Options |
|-------|------------------------------|-----------------|-------------------|
| 2     | Local power isolating device | NO              |                   |
| 3     | Type                         | NA              |                   |
| 4     | Protection relay required    | NA              |                   |

### 5.4.3 RELAY PROTECTION SYSTEM

#### 5.4.3.1 PROTECTION DEVICES FOR POWER DISTRIBUTION SYSTEM

Protection devices for power distribution system shall be as indicated below -  
(Figure inside bracket refers to points against Sr. No. under clause 5.4.3.3)  
(YES - Applicable)

| S.No. | Relay Description  | Relay No. | HV Transformer Feeder - Sec. Winding Volt=>3.3kv | HV Transformer Feeder - Sec. Winding Volt<=0.433kv | HV Motor Feeder | Outgoing Breaker Feeder - HV Plant Feeder | Outgoing Breaker Feeder - MV PCC/PMCC | Incomer - EHV/HV | Incomer - MV PCC/PMCC |
|-------|--|-----------|--|--|-----------------|---|---------------------------------------|------------------|-----------------------|
| 1     | IDMTL over-current relay                                   | 51        | YES  | YES  | -               | YES                                       | YES                                   | YES (1)          | YES                   |
| 2     | IDMTL earth-fault relay                                    | 51N       | YES(2)   | YES  | -               | YES                                       | YES                                   | YES (1)          | YES                   |
| 3     | 51G backup earth-fault relay (Earthed neutral)             | 51G(11)   |  |  | -               | -   | -                                     | YES              | YES                   |
| 4     | Motor protection relay with (50, 50N,46, 49, 50L/R,86,95 ) | 99(31)    | -  | -  | YES(3)          | -   | YES(3)                                | -                | -                     |
| 5     | Instantaneous restricted earth-fault relay (Earthed side)  | 64R(11)   | -  | -  | -               | -   | -                                     | YES(24)          | YES                   |
| 6     | Instantaneous over-current relay                           | 50        | YES  | YES  | -               | -   | -                                     | -                | -                     |
| 7     | Instantaneous earth-fault relay                            | 50N       | YES(4)   | YES  | -               | -   | -                                     | -                | -                     |
| 8     | Differential protection relay                              | 87        | YES(5)   | -  | YES(6)          | YES(7)                                    | -                                     | -                | -                     |

| S.No. | Relay Description  | Relay No. | HV Transformer Feeder - Sec. Winding Volt=>3.3kv | HV Transformer Feeder - Sec. Winding Volt<=0.433kv | HV Motor Feeder | Outgoing Breaker Feeder - HV Plant Feeder | Outgoing Breaker Feeder - MV PCC/PMCC | Incomer - EHV/HV | Incomer - MV PCC/PMCC |
|-------|--|-----------|--|--|-----------------|---|---------------------------------------|------------------|-----------------------|
| 9     | High speed tripping relay                                | 86(20)    | YES  | YES  | YES             | YES                                       | YES                                   | YES              | YES                   |
| 10    | Trip circuit supervision relay                           | 95(8)     | YES  | YES  | YES             | YES                                       | YES                                   | YES              | YES                   |
| 11    | Transformer auxiliary relay                              | 63        | YES  | YES  | -               | -   | -                                     | -                | -                     |
| 12    | Under-voltage relay with timer                           | 27/2      | -  | -  | YES             | -   | YES(3)                                | YES(9)           | YES(9)                |
| 13    | Check synchronisation relay                              | 25        | -  | -  | -               | -   | -                                     | YES(10)          | YES(10)               |
| 14    | CBCT based sensitive earth fault protection              | 50N       | YES  | YES  | YES             | -   | YES (Motor Feeders)                   | -                | -                     |
| 15    | Voltage restrained overcurrent with local breaker backup | 51V + LBB | YES(34)  |  |                 |   |                                       | YES(34)          |                       |

#### 5.4.3.2 POWER GENERATION AND EXTERNAL POWER SUPPLY

| S.No. | Relay Description        | NEMA Code | Generator | Generator Transformer | EHV Incomer | EHV Transformer | Syn. Motor |
|-------|--------------------------|-----------|-----------|-----------------------|-------------|-----------------|------------|
| 1     | Distance protection      | 21        |           |                       | YES         |                 |            |
| 2     | Synchronous check        | 25        | YES       | YES                   | YES         |                 |            |
| 3     | Under voltage with timer | 27        | YES       |                       | YES         |                 | YES        |
| 4     | Reverse power            | 32        | YES       |                       |             |                 | YES        |
| 5     | Low power flow           | 37        | YES       |                       |             |                 |            |

| S.No. | Relay Description                  | NEMA Code | Generator | Generator Transformer | EHV Incomer | EHV Transformer | Syn. Motor |
|-------|------------------------------------|-----------|-----------|-----------------------|-------------|-----------------|------------|
| 6     | Loss of excitation                 | 40        | YES       |                       |             |                 | YES        |
| 7     | Negative sequence                  | 46        | YES       |                       |             |                 | YES        |
| 8     | Over current                       | 50        |           |                       |             | YES             | YES        |
| 9     | Earth fault relay                  | 50N       |           |                       |             | YES             | YES        |
| 10    | Over current                       | 51        |           |                       | YES         | YES             |            |
| 11    | Voltage restrained                 | 51V       | YES       | YES                   |             |                 |            |
| 12    | Earth Fault back up                | 51G       | YES       | YES                   |             | YES             |            |
| 13    | Over current E/F                   | 51N       |           | YES                   | YES         | YES             |            |
| 14    | Over voltage with timer            | 59        | YES       |                       | YES         |                 | YES        |
| 15    | VT failure                         | 60        | YES       |                       |             |                 | YES        |
| 16    | Auxiliary relay for transformer    | 63TX      |           | YES                   |             | YES             |            |
| 17    | Transformer Restricted Earth Fault | 64R       | YES(26)   | YES                   |             | YES             |            |
| 18    | Stator back up earth fault         | 64G       | YES       |                       |             |                 |            |
| 19    | Generator Rotor Earth fault        | 64R       | YES       |                       |             |                 | YES        |
| 20    | Directional O/C                    | 67        |           |                       | YES         |                 |            |
| 21    | Directional E/F                    | 67N       |           |                       | YES         |                 |            |
| 22    | Under frequency/df/dt              | 81        | YES       |                       | YES         |                 | YES        |
| 23    | Tripping relay                     | 86        | YES       | YES                   | YES         | YES             | YES        |
| 24    | Gen differential                   | 87G       | YES       |                       |             |                 |            |
| 25    | Gen and Transformer differential   | 87GT      |           | YES                   |             |                 |            |
| 26    | Transformer differential           | 87T       |           | YES                   |             | YES             |            |
| 27    | Feeder differential                | 87F       |           |                       |             | YES             |            |

| S.No. | Relay Description              | NEMA Code    | Generator | Generator Transformer | EHV Incomer | EHV Transformer | Syn. Motor |
|-------|--------------------------------|--------------|-----------|-----------------------|-------------|-----------------|------------|
| 28    | Bus bar differential and check | 87B/<br>87CH |           | YES                   |             |                 |            |
| 29    | Trip circuit supervision       | 95           | YES       | YES                   | YES         | YES             |            |
| 30    | Dead bus charging relay        | 98           | YES       | YES                   | YES         |                 |            |
| 31    | Over fluxing                   | 99           | YES       | YES                   |             |                 |            |
| 32    | Out of step                    | 78           | YES       |                       |             |                 | YES        |

#### 5.4.3.3 RELAY PROTECTION PHILOSOPHY

| S.No. | Project Philosophy   |
|-------|--|
| 1     | In case of HV switchboards with continuous parallel operation of incomers, 67 and 67N (Directional IDMTL over current and earth fault) relays for the incomers shall be provided.  |
| 2     | Instantaneous earth fault (50N) shall be provided only for transformer with delta primary.   |
| 3     | For breaker fed motor feeders only.<br>Following protections shall also be provided in the numerical protection relays for motors<br>a) No. of start<br>b) Stall protection - with provision for separate settings for start and running condition<br>c) Undervoltage protection - including three phase PT input and Bus PT secondary MCB feedback along with check for current variation |
| 4     | Directional IDMTL earth fault (67N) shall be provided for transformer with star primary.   |
| 5     | For transformers rated 5 MVA and above.  |
| 6     | For motors rated 1500 kW and above, excluding VFD fed motors.  |
| 7     | To be provided for all EHV & HV plant feeders. A plant feeder implies outgoing feeders from one switchboard to another switchboard of same voltage level. Feeder differential relay shall be provided with OFC for communication between the two relays.   |
| 8     | Both 95B & 95 relay shall be provided as part of the numerical relay for HV/ MV feeders wherever numerical relays are provided.  |
| 9     | For HV & MV switchboards wherever auto-changeover feature is provided.<br>Additionally buscoupler provided in these switchboards shall be provided with Closing coil supervision scheme.   |
| 10    | For switchgears where continuous or momentary paralleling of Incomers is envisaged, check synchronising relay shall be provided.   |
| 11    | 51G and 64R relays for input transformer of VFD system shall be decided by VFD Manufacturer.   |
| 12    | The bus tie feeders in HV switchboards shall be provided with 51, 51N, 86 and 95 relays.   |
| 13    | HV capacitor bank feeders shall be provided with 51, 51N, 59 (over voltage), 60 (Neutral displacement), 86 and 95 relays.  |

| S.No. | Project Philosophy  |
|-------|---|
| 14    | The following feeders shall be provided with timers for delayed tripping on bus under voltage while the under voltage relay shall be common for the bus<br>a. HV and MV capacitor feeders<br>b. HV and MV breaker controlled motor feeders<br>c. Contactor controlled motor feeders with DC control supply.<br>Numerical relays where ever provided for motor and capacitor feeders shall use in built under voltage relay and timer for delayed tripping on bus under voltage. |
| 15    | One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard.  |
| 16    | In case of numerical relays, all relays shall be comprehensive units including all protection, metering & control and communication over IEC-61850 protocol.  |
| 17    | Under voltage and over voltage function along with associated timer shall be part of the numerical relays.  |
| 18    | FBT / Auto changeover logic between Incomers and bus coupler shall be built in the numerical relay.   |
| 19    | Tripping relays (86) shall be conventional electromechanical VAJH or VAJS high burden type only. ABB make PQ8 shall not be used   |
| 20    | 2 Nos. of 86 relays shall be considered for HV and MV breaker fed motors for ease of differentiating between process & electric trip. Master Tripping relays shall be VAJH relay and Process trip relay shall be VAJS relay.  |
| 21    | Breaker control switch shall be hardwired type.   |
| 22    | Stand by earth fault relay 51G (part of separate 64R relay) shall be provided in the incomer of switchboard fed from transformers and same shall operate 86 relay of incomer & trip coil of upstream transformer feeder (without 86 relay).<br>51G protection shall have selectable IDMT characteristics including IEC LTI curves.  |
| 23    | Restricted earth fault relay 64R shall be provided for transformer rating $\geq 1.25$ MVA in the incomer of switchboard fed from transformers with secondary winding connected in star. Same shall operate trip coil of incomer without operating the 86 relay & shall operate 86 relay of upstream transformer feeder.   |
| 24    | Relay 51V voltage controlled over current relay shall be provided on specific requirement considering the rating of the outgoing feeders with respect to the Incomer rating. Generally this relay shall be provided wherever CT primary current of outgoing feeders is exceeding 40% of the CT primary current of the Incomer.  |
| 25    | 415V DG set shall be provided with protection but not limited to 51V,51G,40,46,86,95,80,64R etc for generator rated above 500KVA and Generator rated less than 500KVA shall have 51V,51G,40,46,86,95,80 unless otherwise agreed with the owner.   |
| 26    | Relay 87 and 64R shall be separate numerical relay. Hence shall not be part of main comprehensive numerical relay. CT for 87 and 64R can be clubbed, as two core of single CT.  |
| 27    | EHV switchboards shall be provided with low impedance type bus bar differential protection system with provision of manual bypass. Check zone relay (87CH) shall be provided as a separate relay.   |
| 28    | All HV switchboards (6.6kV) shall be provided with One set of 87B (Bus differential - High impedance type with manual bypass feature) relay with CT supervision relay and 95 B (Bus wire supervision) for each bus section.   |

| S.No. | Project Philosophy  |
|-------|---|
| 29    | <p>Feeders for all MV motors rated upto 55kW shall be provided with Digital MPR.</p> <p>DMPR relay shall have following features which are listed below:</p> <ol style="list-style-type: none"> <li>1) Multi-Protection : thermal overload(different curves/thermal constant), Stall(settable), Lock rotor(settable), phase unbalance, phase reversed Asymmetry, Ground fault (with option of instantaneous trip time), Short circuit (with option of instantaneous trip time)</li> <li>2) Display for causes of the type of fault and values 3 phase &amp; earth element current in digital ampere meter</li> <li>3) Display for running three phase current, Motor load (%)</li> <li>4) CT ratio shall be settable in Digital MPR</li> <li>5) Feeders for all MV motors above 11 kW shall be provided with CBCT+ELR. CBCT shall be mounted on the drawout module only. DMPR &amp; ELR shall be considered as a single relay for these cases.</li> </ol> |
| 30    | Stabilizing resistor shall be provided in residual earth fault connection for all motors and transformers even in case of numerical relays to avoid spurious tripping during starting.  |
| 31    | All HV/MV Motors with numerical relays shall have provision for "Ready to start" monitoring facility which can provided alarm output contact for interfacing with DCS/PLC. This shall monitor the healthiness of relay/control system/spring charge condition of breaker and interlocks/stop command etc. Interface with DCS/PLC shall be as per interface requirements.  |
| 32    | Undervoltage tripping shall be blocked in case of PT fuse failure in motor protection relays.   |
| 33    | All the control switches provided for electrical control shall be non-lockable type.  |
| 34    | Only for incoming and outgoing feeders on primary distribution boards(EHV & 33kV)   |
| 35    | Relay logic shall be designed such that it is ensured that no trip will be generated in case of DC failure & restoration.   |
| 36    | <p>For transformer feeders having supply from remote substation, OFC based remote I/O module / teleprotection shall be used to share following signals:</p> <ol style="list-style-type: none"> <li>a) Transformer incipient faults (Buchholz/OTI/WTI)</li> <li>b) Direct intertrip</li> <li>c) Status (ON/OFF/ Trip)</li> </ol>   |

## 5.4.4 METERING

### 5.4.4.1 METERING DEVICES IN EHV, HV AND MV SWITCHBOARDS

The metering devices in EHV, HV and MV switchboards shall be as below:

Type of metering : Analogue/As part of the Numerical relay

(Figure inside bracket refers to note below) (YES - Applicable)

| S.No. | Feeder Type               | A   | V   | Hz  | PF  | MW      | MWH      | HM  | MVAR   | MVAH   | MVA      |
|-------|---------------------------|-----|-----|-----|-----|---------|----------|-----|--------|--------|----------|
| 1     | Grid Incomers             | YES | YES | YES | YES | YES(2)  | YES      | -   | YES(2) | YES(2) | YES(1,2) |
| 2     | Grid Bus Tie              | YES |     |     |     |         |          |     |        |        |          |
| 3     | Grid Transformer          | YES |     |     |     | YES     | YES      |     |        |        |          |
| 4     | Grid Bus P.T.             |     | YES |     |     |         |          |     |        |        |          |
| 5     | EHV/HV Incomer            | YES | YES | YES | YES | YES     | YES      | -   | YES    | YES    | YES      |
| 6     | EHV/HV Bus Tie            | YES | -   | -   | -   | -       | -        | -   | -      | -      | -        |
| 7     | EHV/HV Transformer        | YES | -   | -   | -   | YES     | YES      | -   | -      | -      | -        |
| 8     | EHV/HV Bus P.T.           | -   | YES | -   | -   | -       | -        | -   | -      | -      | -        |
| 9     | EHV/HV Plant Feeder       | YES | -   | -   | -   | -       | YES      | -   | -      | -      | -        |
| 10    | EHV/HV Motor              | YES | -   | -   | -   | -       | YES(kWh) | YES | -      | -      | -        |
| 11    | EHV/HV Capacitor          | YES | YES | -   | -   | -       | -        | -   | YES    | -      | -        |
| 12    | PCC/PMCC Incomer          | YES | YES | -   | YES | -       | YES(kWh) | -   | -      | -      | -        |
| 13    | PCC/PMCC Bus Tie          | YES | -   | -   | -   | -       | -        | -   | -      | -      | -        |
| 14    | PCC Bus P.T.              | -   | YES | -   | -   | -       | -        | -   | -      | -      | -        |
| 15    | ACB Outgoing ( Non motor) | YES | -   | -   | -   | -       | YES(kWh) | -   | -      | -      | -        |
| 16    | MV Motor (>55kW)          | YES | -   | -   | -   | -       | -        | -   | -      | -      | -        |
| 17    | MCC/ASB Incomer           | YES | YES | -   | -   | -       | -        | -   | -      | -      | -        |
| 18    | MCCB/SFU O/G(250A)        | YES | -   | -   | -   | -       | YES(kWh) | -   | -      | -      | -        |
| 19    | LDB Incomer               | YES | YES | -   | -   | -       | YES(kWh) | -   | -      | -      | -        |
| 20    | DG Set-MV                 | YES | YES | YES | YES | YES(kW) | YES(kWh) | YES | -      | -      | -        |

Notes:

- 1.) MVA meter in EHV external power supply Incomers shall include maximum demand indication also.
- 2.) Separate MW, MVAR, MVA and MVAH meters shall be provided for EHV external power supply Incomers only.
- 3.) Seperate 3 nos. voltmeter and 3 nos. ammeter shall be provided for EHV external power supply incomers.
- 4.) All metering shall be part of numerical relay in case of feeders having numerical relays.
- 5.) Field ammeters shall be provided for all motors rated above 5.5kW. However feeders for all packages Aux. Motor driven pumps and heaters shall be provided with ammeter irrespective of the motor ratings. For PPU in PNCP, motor feeders of all ratings shall have provision of field ammeter.
- 6.) Ammeter (size 48mm x 48mm) shall be provided in space heater circuit of breaker fed HV & MV motors.
- 7.) Digital mutli-function meters shall be provided in all feeders of 6.6kV switchboards. This shall be in addition to metering as part of numerical relays.
- 8.) Digital mutli-function meters shall be provided in incomers, buscoupler & outgoing breaker feeders (except motor feeders) for MV PCC with communication over RS-485 or fibre optic cable, preferably with IEC protocol. This shall be in addition to metering as part of numerical relays for energy management functions.
- 9.) HV Motor feeders shall be provided with 4-20mA current/voltage transducers (as required) for feedback to DCS.
- 10.) Power factor meter shall be provided for synchronous motors in addition to the metering provided for induction motors.
- 11.) Digital mutli-function meters with communication over RS-485 or fibre optic cable, preferably with IEC protocol shall be provided in incomers of UPS ACDB.

#### 5.4.4.2 METERING FOR GENERATOR AND GENERATOR TRANSFORMER

| S.No. | Meter              | HV Generator | Generator transformer |
|-------|--------------------|--------------|-----------------------|
| 1     | Ammeter (3 nos.)   | YES          | YES                   |
| 2     | Voltmeter (3 nos.) | YES          | YES                   |
| 3     | MW meter           | YES          | YES                   |
| 4     | MVAR meter         | YES          |                       |
| 5     | MVA meter          | YES          |                       |
| 6     | MWH meter          | YES          | YES                   |
| 7     | MVARH meter        | YES          |                       |
| 8     | Power factor       | YES          | YES                   |
| 9     | Frequency meter    | YES          |                       |

### 5.5 SUBSTATION DESIGN

#### 5.5.1 SUBSTATION AUTOMATION SYSTEM

| S.No. | Description                               | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 1     | Substation Automation System (SAS)        | Required   |                   |
| 2     | Communication protocol for relay network  | IEC 61850  |                   |
| 3     | System architecture                       | IEC 61850 RSTP   |                   |
| 4     | Data concentrator for SAS                 | Not Required   |                   |
| 5     | Communication with other devices          |  |                   |
| 5.1   | Communication with ECS                    | Yes  |                   |
| 5.1.1 | Protocol for communication with ECS       | IEC 61850  |                   |
| 5.2   | Communication with DCS                    | Part of ECS RTU (Refer Note-3)                           |                   |
| 5.2.1 | Protocol for communication with DCS       | Modbus TCP/IP  |                   |
| 5.3   | Communication with VFD & UPS              | Part of ECS RTU  |                   |
| 5.3.1 | Protocol for communication with VFD & UPS | Modbus TCP/IP  |                   |
| 6     | HMI for SAS                               | Common operator cum engineering workstation              |                   |
| 7     | Laptop                                    | Separate for each switchboard system for each substation |                   |
| 8     | Local storage of data                     | part of HMI  |                   |
| 9     | Relay parameterization                    | SAS HMI  |                   |

- 1.) All functionalities of engineering workstations shall be provided in the LAPTOP.
- 2.) Common HMI (for EHV, HV & MV) shall be provided in each substation for monitoring purpose as part of ECS.
- 3.) For feedbacks to DCS which are used only for indication.
- 4.) Separate UPS for SAS HMI is not required. UPS power shall be provided from common UPS within substation building.

#### 5.5.2 EHV SWITCHYARD

| S.No. | Description           | Selected Option             | Available Options |
|-------|-----------------------|-----------------------------|-------------------|
| 1     | Type                  | \$ Outdoor                  |                   |
| 2     | Type of bus           | \$ String - Moose Conductor |                   |
| 3     | Structure for outdoor | \$ Galvanised               |                   |
| 4     | Bus material          | \$ Aluminium                |                   |

Notes:-

\$- data to be provided/ confirmed by Client

### 5.5.3 SUBSTATION FEATURES

| S.No. | Description   | EHV                 | HV                  | MV                 | MCC/Elec. Room |
|-------|---|---------------------|---------------------|--------------------|----------------|
| 1     | Elevated with trays in cable cellar                                 | NA                  | YES                 | YES                | NO             |
| 2     | Raised with internal trenches                                       | YES                 | NO                  | NO                 | YES            |
| 3     | All top cable entry with trays below ceiling                        | NO                  | NO                  | NO                 | NO             |
| 4     | Pressurisation against ingress of dust                              | NA                  | NA                  | NA                 | NO (NOTE-2)    |
| 5     | Air-conditioned room for operator                                   | YES (NOTE-5)        | YES (NOTE-5)        | YES (NOTE-5)       | NA             |
| 6     | Roof slab for (Refer Note-6)  |                     |                     |                    |                |
| 6.1   | Power transformer   | YES                 | YES                 | NA                 |                |
| 6.2   | Distribution transformer  | NA                  | YES                 | YES                |                |
| 7     | Air conditioning of switchgear hall and provision of false ceiling. | YES                 | YES                 | YES                | NO             |
| 8     | EOT crane in sub-station  | YES                 | NO                  | NO                 | NO             |
| 9     | Electrical Store/Maintenance Room                                   | YES - 2NOS (NOTE-7) | YES - 2NOS (NOTE-7) | YES - 1NO (NOTE-7) | NO             |
| 10    | Washrooms & water filters   | YES                 | YES                 | YES                | NO             |

Notes :

- 1.) Column HV is defined as "Substation having full fledged HV Switchboard having incomer, buscoupler and outgoing switchboards".
- 2.) Not required for MCC rooms located in safe area/ utilities not handling hydrocarbons/ combustible dust.
- 3.) Exhaust fans shall be provided on the two ends of the cable cellar for each substation.
- 4.) Lift for substations with more than two floors shall be provided.
- 5.) Size of operator room shall be 3mx3m. HMIs shall be installed in this room. Room shall be part of switchgear hall with glass partition. CRP & LCC for 220kV GIS shall be installed in the GIS hall.
- 6.) Concrete roof slab on outdoor bays shall be provided at switchgear hall roof level.
- 7.) Maintenance rooms shall be of size 6mx6m.
- 8.) Fire proof sealing system as per IEC-60332 shall be provided below the switchboards in substations and above ground entry points of cables to substations.

9.) Temperature & humidity monitoring for each substation and connected battery charger room/VFD room shall be provided with display and 4-20mA transmitter for interface with ECS.

#### 5.5.4 SPECIFIC EQUIPMENT LOCATIONS

| S.No. | Description                                   | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 1     | Batteries in substation and control Rooms     | Separate room  |                   |
| 2     | Battery charger in substation                 | Switchgear Hall  |                   |
| 3     | Battery charger in control room               | Air conditioned room   |                   |
| 4     | Variable speed drive panels                   | Switchgear Hall  |                   |
| 5     | Thyristor controlled panels                   | Switchgear Hall  |                   |
| 6     | UPS System                                    | Air conditioned room in control room or Satellite rack Room<br>Switchgear hall in substation |                   |
| 7     | Lead-Acid and Nickel-Cadmium                  | Separate room  |                   |
| 8     | Location of VRLA battery                      | Air conditioned room   |                   |
| 9     | Annunciation panel                            | Part of HMI in Operator room   |                   |
| 10    | Energy saver panel with Lighting transformers | Panel mounted type lighting transformer  |                   |
| 11    | GIS Hall                                      | Air Conditioned  |                   |

- 1.) Battery room shall be preferably located in corner side at switchgear floor of the substation building.
- 2.) Battery charger for Instrumentation shall be placed in air-conditioned UPS room in control room.
- 3.) Electrical equipment installed in battery room such as exhaust fan, lighting, battery circuit breakers, receptacles shall be of flameproof enclosure type and certified for gas group IIC classified locations. Heat detectors installed in battery room shall be of intrinsically safe type and shall be provided with Zener barriers.
- 4.) Capacitor panels along with APFCR shall be indoor type, installed in switchgear hall. Dry type series reactor installed inside panel shall be provided with the capacitor banks.
- 5.) All electronic equipment like VFDs, thyristor panels etc shall preferably be located in a separate room (part of air conditioned switch gear room) with glass partition based on space availability.

#### 5.6 EQUIPMENT DESIGN

##### 5.6.1 EHV DESIGN

##### 5.6.1.1 EHV OUTDOOR SWITCHYARD

| S.No. | Description          | Selected Option         | Available Options |
|-------|----------------------|-------------------------|-------------------|
| 1     | Bus bar system       | \$ NA (Part of EHV GIS) |                   |
| 2     | Circuit breaker type | \$ SF6                  |                   |
| 3     | Isolator type        | \$ Centre rotating      |                   |

Notes:-

\$- data to be provided/ confirmed by Client

### 5.6.1.2 EHV SWITCHBOARD

| S.No. | Description          | Selected Option | Available Options |
|-------|----------------------|-----------------|-------------------|
| 1     | Execution            | Fixed           |                   |
| 2     | Type of Switchgear   | GIS SF6         |                   |
| 3     | Busbar               | Double          |                   |
| 4     | Circuit Breaker Type | VCB/SF6         |                   |

Notes :

- 1.) Local control cabinet for 220kV GIS shall be separate free standing type and for 66kV GIS it shall be part of GIS panel.
- 2.) Breaker scheme for GIS shall be informed by client. \$
- 3.) All breakers shall have double trip coils fed from same control supply. Each coil shall have separate trip circuit supervision and tripping scheme/trip fuses.

### 5.6.2 HV SWITCHBOARD

| S.No. | Description          | Selected Option                                     | Available Options |
|-------|----------------------|---|-------------------|
| 1     | Execution            | Fixed for 33kV/<br>Drawout for others               |                   |
| 2     | Type of switchgear   | Gas insulated for 33kV/<br>Air Insulated for others |                   |
| 3     | Bus bar              | Single bus  |                   |
| 4     | Circuit breaker type | VCB   |                   |
| 5     | Motor Control        | Breaker   |                   |

Notes : -

- 1.) Breaker compartment shall be provided with non-metallic shutters.
- 2.) HV switchboards shall be provided with thermography window for infrared electrical inspection.
- 3.) Internal Arc classification for HV switchboards shall be 40kA for 0.2sec.
- 4.) Fast Bus Transfer (FBT) shall be provided for 6.6kV HV Switchboards.
- 5.) Double bus tie circuit breaker shall be provided in all HV Switchboards (6.6kV). Second buscoupler shall be without any kind of numerical relay and shall be provided with Electro mechanical type Trip circuit supervision relay. Status of second buscoupler shall be used in interlock of Auto changeover logic, which shall be implemented in the first buscoupler with numerical relay. There shall not be any feeder in between the both bus coupler.
- 6.) AIS type HV switchboards shall be provided with 4 nos. Non-hygroscopic phase barriers and shrouds shall be provided at uncovered portion of bus-bars. All breakers and cable compartment shall have phase barriers (4 nos. each).

### 5.6.3 CURRENT TRANSFORMER (CT)/POTENTIAL TRANSFORMER (PT)

| S.No. | Description                         | Selected Option                         | Available Options |
|-------|-------------------------------------|---|-------------------|
| 1     | CT Secondary                        |   |                   |
| 1.1   | General Protection                  | 1A                                      |                   |
| 1.2   | Special protection(87,64R ,51G etc) | 1A                                      |                   |
| 1.3   | Metering                            | 1A for conventional and remote metering |                   |

| S.No. | Description  | Selected Option | Available Options |
|-------|--------------|-----------------|-------------------|
| 2     | PT Secondary | 110V AC         |                   |

#### 5.6.4 TRANSFORMERS (POWER/DISTRIBUTION)

| S.No. | Transformer                                      | Voltage Ratio                     | Vector Group | Tap Changer | Cooling   |
|-------|--|-----------------------------------|--------------|-------------|-----------|
| 1     | Grid power transformer / Grid Supply Transformer | 220/69kV                          | YNyn0        | OLTC        | ONAN/ONAF |
| 2     | Generator unit transformer                       | NA                                | YNd 11       | Off-circuit | ONAN/ONAF |
| 3     | Intermediate power transformer                   | 66/6.9kV, 33/6.9kV (Refer Note-8) | Dyn 1        | OLTC        | ONAN/ONAF |
| 4     | Dedicated (e.g. for VFD)                         |                                   | As Req'd.    | Off-circuit | ONAN      |
| 5     | Distribution transformer (<= 2500 KVA)           | 6.6/0.433kV                       | Dyn 11       | Off-circuit | ONAN      |
| 6     | Tie Transformer                                  | 66/66kV                           | YNyn0        | OLTC        | ONAN/ONAF |

#### Notes :

- 1.) Provision of Oil Soak Pit & Oil Collection Pit for transformers shall be as follows:
  - a) Oil quantity <= 2000L: Not Required
  - b) 2000L < Oil Quantity <= 9000L: Soak Pit
  - c) Oil Quantity > 9000L: Soak Pit + Collection Pit
- 2.) EHV transformer shall be provided with both NIFPS & HWWS based fire fighting system. For all other power transformers rated above 10MVA or with oil quantity greater than 2000 Liters, HWWS based fire fighting system shall be provided. Deluge valve assembly shall be provided canopy/shed.
- 3.) Bucholz relay, OTI & WTI shall be provided with reed type switches in place of mercury switches.
- 4.) Online De-hydration facility shall be provided in all transformers rated greater than 5MVA.
- 5.) Dedicated panel mounted transformers provided for VFDs shall have maximum efficiency at operating load of motor.
- 6.) EHV Side terminal box for EHV power transformer shall be of oil filled type only.
- 7.) OLTC for Grid transformer shall have RTCC panel with Dual redundant AVR facility.
- 8.) 66/6.9kV transformer is applicable for refinery side facilities. 33/6.9kV transformer is applicable for PNCP side facilities.

#### 5.6.5 MV SWITCHBOARD

| S.No. | Description        | Selected Option                   | Available Options |
|-------|--------------------|-----------------------------------|-------------------|
| 1     | PCC / PMCC         |                                   |                   |
| 1.1   | Breaker panels     | Drawout Single front              |                   |
| 1.2   | Contactors feeders | Drawout Single Front (See Note-1) |                   |
| 2     | MCC                | Drawout Single Front (See Note-1) |                   |
| 3     | ASB                | Drawout Single Front (See Note-1) |                   |

| S.No. | Description   | Selected Option                   | Available Options |
|-------|---|-----------------------------------|-------------------|
| 4     | LDB   | Drawout Single Front (See Note-1) |                   |
| 5     | Motors  |                                   |                   |
| 5.1   | PMCC  | Above 55 kW Up to 160 kW          |                   |
| 5.2   | MCC   | Up to 55 kW                       |                   |
| 6     | Type of switchboard for small package (AC system, Pressurisation system, Bagging plant etc) | Compartmentalised Fixed type      |                   |

Note:-

- 1.) MCCs, ASB, LDB may be considered Double Front where required due to space limitations in the building.
- 2.) Rating of MCC shall be limited upto 1250A.
- 3.) Switchboards upto 4000A shall be naturally cooled. No force cooling shall be accepted.
- 4.) For PCC/PMCC/EPCC internal arc protection system shall be provided.

### 5.6.6 MEDIUM VOLTAGE MOTOR STARTER TYPE

| S.No. | Description  | Selected Option  | Available Options |
|-------|--|--|-------------------|
| 1     | Contact and switch fuse with overload relay                                  | NA   |                   |
| 2     | Contact, switch fuse and overload relay with CBCT for earth fault protection | Above 11kW & up to 55KW with DMPR where Overload relay, ELR shall be part of DMPR (Refer Note 1) |                   |
| 3     | Contact and switch fuse with motor protection relay                          | Upto 11kW with DMPR where Overload relay shall be part of DMPR                                   |                   |
| 4     | Air circuit breaker with motor protection relay                              | Above 55kW up to 160KW (Refer Note 1)  |                   |
| 5     | Contact and MCCB with overload relay   | NA   |                   |
| 6     | Contact, MCCB and overload relay with CBCT for earth fault protection        | NA   |                   |

- 1.) All motor feeders above 11kW shall be provided with CBCT based earth fault protection.

### 5.6.7 MEDIUM VOLTAGE OUTGOING FEEDER TYPE

| S.No. | Description  | Selected Option   | Available Options |
|-------|--|---|-------------------|
| 1     | Switch fuse  | Up to 100A  |                   |
| 2     | Switch fuse with Contactor and CBCT for earth fault protection | Above 100A and upto 250A.<br>32/63A for Aux. Heater Feeders |                   |

| S.No. | Description   | Selected Option | Available Options |
|-------|---|-----------------|-------------------|
| 3     | MCCB with Contactor and CBCT for earth fault protection | NA              |                   |
| 4     | MCCB  | NA              |                   |

Note:-

- 1.) Feeders of all other ratings not listed above shall be provided with ACB.

### 5.6.8 MOTOR CONTROLS (AS PER PROCESS PACKAGE & OPERATING PHILOSOPHY)

| S.No. | Description              | Selected Option     | Available Options |
|-------|--------------------------|---------------------|-------------------|
| 1     | Auto/OFF/Manual switch   | Control room        |                   |
| 2     | Local/OFF/Remote switch  | Near motor          |                   |
| 3     | Process interlock        | PLC(Note-1)         |                   |
| 4     | Reacceleration equipment | Switchgear (Note-3) |                   |

Note:-

- 1.) To be made available at Switchgear as per instrumentation philosophy.
- 2.) For contactor fed motors and where required by OEM of a system "STOP" shall be "Break or Open to Trip". For all other motors, Field Stop PB, EPB Commands and DCS stop / process trip command shall be of "make or close to trip" type.
- 3.) Electronic TRUE OFF Delay & ON Delay timers shall be provided. Aux supply shall not be used for timers.

### 5.6.9 CONTROL SUPPLY VOLTAGE

| S.No. | Description  | Selected Option                    | Available Options |
|-------|--|------------------------------------|-------------------|
| 1     | Breaker control  | 110V DC<br>220V DC for PPU in PNCP |                   |
| 2     | Breaker spring charging  | 110V DC<br>220V DC for PPU in PNCP |                   |
| 3     | Contactor feeder   | 240V AC                            |                   |
| 4     | Control supply for earth fault relay in contactor feeder(Note 1) | 240V AC                            |                   |
| 5     | Control supply for contactor motor starter                       | Control Transformer                |                   |
| 6     | Control transformer for each feeder                              | Yes                                |                   |

Notes:

- 1.) Control supply shall be derived from for incoming supply to the feeder module.
- 2.) Control supply for thyristor based heater panels for process heaters, ECS Panels, LAN, HMIs in substation, VFDs & Soft starters shall be 230V AC supplied from dedicated UPS installed in the substation.
- 3.) Common 220V DC system shall be used for both control & lighting in offsite MCC rooms.
- 4.) Each bus section of a switchboard shall be provided with independent control supply. Provision for bumpless auto transfer in case of loss of one supply shall be provided. There shall also be provision for manual transfer. Monitoring of failure of supply, availability of source and monitoring auto status shall be provided.

## 5.6.10 MOTORS

| S.No. | Motors  | High voltage   | 415 volts                         |
|-------|---|--|-----------------------------------|
| 1     | Enclosure                                       |  |                                   |
| 1.1   | Indoor  | IP55   | IP55                              |
| 1.2   | Outdoor   | IP55   | IP55                              |
| 2     | Insulation class                                | F (Temp. Rise limited to B)                                  | F (Temp. Rise limited to B)       |
| 3     | Anti-condensation heater                        | Yes  | 22 kW and Above                   |
| 4     | Additional canopy (outdoor motors)              | Yes  | Yes                               |
| 5     | Design voltage variation                        | ±10%   | ±10%                              |
| 6     | Design frequency variation                      | ±3%  | ±3%                               |
| 7     | Combined voltage / frequency variation (Design) | ±10 %<br>Any combination of above                            | ±10 %<br>Any combination of above |
| 8     | Winding/Bearing RTD                             | 6 nos. duplex winding RTDs<br>2 nos. bearing RTDs (Note-4&5) | PTC thermistors (Note-6)          |

### Notes :

- 1.) Motors for MOV actuator shall have H class of insulation with temperature rise limited to class-B.
- 2.) HV motors terminal box shall be phase segregated. Other variations shall be considered in case of limited availability.
- 3.) MV motors for hazardous and safe area shall have efficiency class as IE3 as per IS 12615:2011.
- 4.) Dual dial type temperature indicator without contacts, mounted on motor body, for bearing temperature should be provided for all HV motors.
- 5.) Refer Clause 4 Note 26 for RTD/BTD configuration.
- 6.) To be provided for all VFD driven MV motors. Also for other MV motors wherever required for process/DCS monitoring.

## 5.6.11 UPS SYSTEM

| S.No. | Description                             | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 1     | Redundancy                              | 100%   |                   |
| 2     | Type of redundancy                      | Parallel redundant with individual bypass                            |                   |
| 3     | Back-up time                            | 120 minutes  |                   |
| 4     | Bypass transfer control                 | Auto   |                   |
| 5     | Separate fault diagnostic unit (Note 1) | YES  |                   |
| 6     | Battery type                            | Ni-Cd (2X100% configuration in all options)                          |                   |
| 7     | Type of UPS                             | Rectifiers : Diode/SCR<br>Invertor : IGBT                            |                   |
| 8     | UPS Output Supply                       | Single Phase   |                   |
| 9     | UPS Output Voltage                      | 110V AC (Final voltage shall be as per Instrumentation Design Basis) |                   |

### Notes :

- 1.) Separate Fault Diagnostic Unit(FDU) is not required in case UPS system is serial connected to HMI and fault diagnostic can be done from HMI. However UPS shall be provided with self powered disturbance recorder with internal battery backup.
- 2.) 1No. 230V 20KVA UPS in parallel redundant with bypass configuration (2x50% battery banks) shall be provided for feeding CFAP, fire alarm HMI and other miscellaneous equipment as per client requirements in the fire station.
- 3.) Complete redundancy shall be provided in UPS till the distribution board level.
- 4.) Refer Clause 4 Note 7 for ACDB configuration.
- 5.) ACDB outgoing feeders shall SFU type with semiconducting fuses.
- 6.) In case of space constraint, ACDB shall be split and different sections shall be connected through busduct as required.
- 7.) Dedicated UPS with 230V AC output shall be installed in the substation for providing control supply to thyristor based heater panels for process heaters, ECS Panels, LAN, SAS HMIs, VFDs & Soft starters installed in substation. In case of common substation for different process units, separate UPS system for the above shall be provided for different units where separate HV switchboards are provided for different units.
- 8.) Online battery bank monitoring system shall be provided for main process UPS batteries. Provision for individual cell temperature, cell voltage & cell impedance shall be monitored and common alarm shall be provided for each category. Battery monitoring system shall have connectivity with ECS system and remote alarm facilities.

#### 5.6.12 COMMUNICATION SYSTEM

| S.No. | Description                                     | Selected Option        | Available Options |
|-------|---|------------------------|-------------------|
| 1     | Plant Communication System                      | Yes                    |                   |
| 2     | Telephone System                                | Yes (Refer Note-1 & 2) |                   |
| 3     | Telephone system and plant Communication system | Separate               |                   |
| 4     | Interface of Communication system               |                        |                   |
| 4.1   | With fire alarm system                          | Yes                    |                   |
| 4.2   | With telephone system                           | Yes                    |                   |

#### Notes :

- 1.) Basic telephone handset with minimal display shall be procured through Building/Package contractor. Special purpose handsets with advanced functions shall be procured by Client at their end.
- 2.) Flameproof telephones in high noise area shall be provided with along with acoustic hood/soundproof booth in field area as per space availability.
- 3.) PA System for PPU in PNCP shall be hooked up to the existing system at PNCP.
- 4.) Telephone exchange for new plant shall be integrated with existing telephone system at the refinery complex (PR).

#### 5.6.13 FIRE DETECTION AND ALARM SYSTEM

| S.No. | Description                                     | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 1     | Type  | Analogue addressable   |                   |
| 2     | Name of buildings to be provided with Detectors | Control room, sub-station, SRR, other buildings as required. |                   |
| 3     | Detection System                                | Break Glass, Multi sensor detection                          |                   |
| 4     | Type of manual call point                       | Without call back facility                                   |                   |
| 5     | Qty of Siren and location                       | During detail engineering                                    |                   |

| S.No. | Description   | Selected Option   | Available Options |
|-------|---|---|-------------------|
| 6     | Power supply for Siren  | Main Sirens : 415V AC<br>For small indoor siren : during detailed engineering |                   |
| 7     | Siren range   | 16 Km(Diametrically)  |                   |
| 8     | Response indicator for rooms and concealed area for Addressable Fire alarm system | No  |                   |

Notes :

- 1.) HMI for Fire Alarm System shall be provided along with CFAP in Main Fire Station.
- 2.) Heat detectors installed in battery room shall be of intrinsically safe type and shall be provided with Zener barrier.
- 3.) Fire Alarm System for PPU in PNCP shall be hooked up to the existing system at PNCP.
- 4.) Repeater panel of new FA system of P-25 shall be provided in PR Fire station.
- 5.) 4 Nos DC sirens shall be provided in P-25 project areas (refinery area only). One siren shall be located on Fire station and other shall be distributed geographically.

### 5.6.14 DC SYSTEM

| S.No. | Description   | Selected Option                                | Available Options |
|-------|---|--|-------------------|
| 1     | Battery type  |  |                   |
| 1.1   | Switchgear Protection Control and critical lighting | Ni-Cd  |                   |
| 1.2   | Instrumentation System                              | Ni-Cd  |                   |
| 1.3   | Diesel Engine Starting                              | Lead Acid                                      |                   |
| 1.4   | DC Motors   | As per equipment supplier"s recommendation     |                   |
| 1.5   | Fire alarm system                                   | VRLA   |                   |
| 1.6   | Telephone system                                    | Ni-Cd  |                   |
| 1.7   | End Cell Voltage                                    |  |                   |
| 1.7.1 | Lead Acid Battery                                   | 1.85 VOLT                                      |                   |
| 1.7.2 | VRLA Battery  | 1.75 VOLT                                      |                   |
| 1.7.3 | Ni-Cd Battery                                       | 1.16 VOLT                                      |                   |
| 2     | Battery backup time                                 |  |                   |
| 2.1   | Switchgear Protection and Control                   | 120 minutes                                    |                   |
| 2.2   | DC Critical lighting                                | 120 minutes                                    |                   |
| 2.3   | Instrumentation                                     | 120 minutes                                    |                   |
| 2.4   | Diesel Engine Starting                              | 10 starts (FW pumps) & 6 starts (others)       |                   |
| 2.5   | DC Motors   | As per equipment manufacturer's recommendation |                   |
| 3     | Battery Configuration                               | 2X50%  |                   |

Notes :

- 1.) Refer Clause 4 Note 8, for DCDB configuration.
- 2.) DCDB outgoing feeders shall be SFU type with HRC fuses
- 3.) Battery chargers shall be SMPS based and shall be of Dual FCBC Charger type.
- 4.) Common online cell booster suitable for largest battery rating shall be provided in each substation & SRR building for similar battery systems.
- 5.) DC Earth fault monitoring relay shall be provided on the battery charger and DCDB shall

be provided with a voltmeter & selector switch which have facility to check DC positive to negative, positive to earth & negative to earth voltage, Also separate annunciation for same shall be provided and indicated to ECS.

6.) Online battery bank monitoring system shall be provided for DC control supply battery banks. Provision for individual cell temperature, cell voltage & cell impedance shall be monitored and common alarm shall be provided for each category. Battery monitoring system shall have connectivity with ECS system and remote alarm facilities.

7.) For switchgear protection and control, in case of common substation for different process units, separate DC system shall be provided for different units where separate HV switchboards are provided for different units.

8.) For critical lighting, common DC system for each substation building, irrespective of the various units fed from that substation, shall be provided.

### 5.6.15 VARIABLE FREQUENCY DRIVE

| S.No. | Description              | Selected Option   | Available Options                    |
|-------|--------------------------|---|--------------------------------------|
| 1     | By pass feature required | Yes(Note-1)   |                                      |
| 2     | VFD rated output voltage |   | Incase where bypass is not provided. |
| 2.1   | MV Inverter              | i) 415V for motor kW rating less than 315kW<br><br>ii) 690V for motor kW rating more than 315kW & up to 700kW |                                      |
| 2.2   | HV Inverter              | 6.6kV for motor rating more than 700kW  |                                      |

Notes:

1.) Bypass for VFD shall be provided as a standard practice unless not recommended from Process or driven equipment operation point of view.

2.) For single large/critical drives with VFD, redundant VFDs (Hot Standby) along with redundant PLC for change over without any common point of failure shall be provided. Drives for motor driven ID/FD Fan, RGC, MAB, WGC & MUG compressor with only single drive shall be considered as critical drive. In case of PPU in PNC Reactor Agitator drive, pelletizer cutter motor drive shall be provided with hot standby drive.

3.) All drives for critical applications as listed above shall be provided with HMI for trending & diagnostics features.

### 5.6.16 CABLE SIZES

The power and control cables shall have the following minimum cross sectional areas

| S.No. | Description                | Selected Option  | Available Options |
|-------|----------------------------|--|-------------------|
| 1     | Medium voltage power cable | Upto 16 sqmm (Copper)<br>Above 16 sqmm (Aluminium)<br>XLPE Insulated |                   |
| 2     | Control cables             | 2.5 sqmm (Copper) (Note-4)   |                   |
| 3     | Lighting                   | 2.5 sqmm (Copper)  |                   |
| 4     | Communication system       | 0.9 mm dia. (Copper)   |                   |
| 5     | Telephone System           | 0.63 mm dia.(Copper)   |                   |
| 6     | Fire alarm system          | 1.5 sqmm (Copper)  |                   |

Notes:

- 1.) For lighting inside the building, minimum 1.5 sqmm copper conductor, PVC Insulated wire shall be used in conduit system (for circuit and point wiring), with proper colour coding.
- 2.) Cable sizes are indicative only and these shall be finalised as per the recommendations of the equipment manufacturer.
- 3.) Special cable type and size shall be decided on specific requirement.
- 4.) Control cable shall be of multistranded conductor, twisted pair overall shielded, XLPE insulated type.
- 5.) Communication cables used in PA / Telephone system shall be with solid conductors and XLPE insulated type.
- 6.) Cables used in FA system shall be of multistranded conductor, twisted pair, XLPE insulated type.
- 7.) All cables shall be with FRLS outer sheath.
- 8.) For all control cables minimum 1Pair shall be provided as spare.
- 9.) For MOVs, where control cable length is more than 500m, for DCS command 2 parallel conductors shall be used for each command.
- 10.) All cables for DC system for both control and lighting from Battery charger & DCDB onwards shall be with copper conductors only.
- 11.) All cables for UPS system from UPS & ACDB onwards shall be with copper conductors only.

## 5.7 CABLING SYSTEM

### 5.7.1 CABLE DETAILS

| S.No. | Design Criteria   | EHV  | HV   | 415 volts                            |
|-------|---|--|--|--------------------------------------|
| 1     | Loads located beyond 1 km                                   | 1-core cable   | 3-core cable   | 1-core cable / 3 1/2-core            |
| 2     | Loads located 200-1000 m                                    | 1-core cable   | 3-core cable   | 1-core cable / 3 1/2-core            |
| 3     | Loads located upto 200 m                                    | 1-core cable   | 3-core cable   | 1-core cable / 3 1/2-core            |
| 4     | Loads beyond 1250A rating and located near the transformer. | Gas Insulated Busduct / 1 core cable   | Bus duct   | Bus duct / 1-core cable / 3 1/2-core |
| 5     | Recommended limiting size of multi-core cable (sqmm)        | 1000   | 300  | 300                                  |
| 6     | Short-circuit withstand time (seconds)                      | 1.Incomer from transformer:1<br>2.Incomer from other switchboard:1<br>3.Plant feeder:1<br>4.Transformer feeder:1 | 1.Incomer from transformer:1<br>2.Incomer from other switchboard:0.6<br>3.Plant feeder:0.6<br>4.Transformer feeder:0.4<br>5.Motor feeder:0.2 | Not Applicable                       |
| 7     | Insulation voltage grade                                    | Earthed  | 33kV Earthed<br>6.6kV Unearthed  | Earthed                              |
| 8     | Type of cable insulation                                    | XLPE   | XLPE-FRLS  | XLPE-FRLS                            |
| 9     | Fire survival (Resistant) cable for Fire proof MOV          | -  | -  | Yes (Both Power & Control)           |

| S.No. | Design Criteria            | EHV      | HV                                 | 415 volts           |
|-------|----------------------------|----------|------------------------------------|---------------------|
| 10    | Power Cable for Motors/MOV | -        | 3 core                             | 3 core              |
| 11    | Cable Conductor            | Copper   | Copper/Aluminium<br>(Refer Note-7) | Refer Cl.<br>5.6.16 |
| 12    | Power & Earthing cable     | Armoured | Armoured                           | Armoured            |

Notes :-

- 1.) Water swallowable tape shall be provided in the 66kV & 33kV cables only.
- 2.) All EHV/HV cables shall be with graphite coating.
- 3.) HV Busduct shall be Phase Segregated Air Insulated type.
- 4.) MV Busduct shall be Phase insulated Sandwich type.
- 5.) EHV GIBD shall be phase separated SF6 Insulated type.
- 6.) In case different material are provided for busbar of switchboards/transformers and busducts, bimetallic washer/plates shall be provided.
- 7) Power cables at 33kV level shall be with copper conductor

### 5.7.2 CABLE LAYING PHILOSOPHY

| S.No. | Description                            | Selected Option                         | Available Options |
|-------|--|---|-------------------|
| 1     | Process area                           | RCC trench, sand filled without racks   |                   |
| 2     | Offsite paved area                     | Above Ground cable tray on sleeper      |                   |
| 3     | Offsite unpaved area                   | Above Ground cable tray/Directly buried |                   |
| 4     | Type of cable trays                    | Hot Dip Galvanized prefabricated        |                   |
| 5     | Road Crossings for underground cables  | Cable culvert                           |                   |
| 6     | Road Crossings for Above ground cables | Overhead cable bridge                   |                   |

Notes :

- 1.) Plant communication, fire alarm and telephone cables shall be laid in instrumentation overhead cable duct / instrumentation trenches as far possible. In case these are not available, cable shall be laid in electrical routes along berm of the roads.
- 2.) Walkways shall be provided on either side of cable tray (with ladders at regular intervals) to facilitate movement of people while pulling cable.
- 3.) Cable entry of electrical cables to CR/SRR shall be through underground / covered sleeves.
- 4.) EHV cables shall be laid in RCC trench, sand filled without racks.
- 5.) Cables, before and after upto a length of 2m from the GI kick pipe entry in process area & pump houses shall be provided with fire proof coating as per IEC-60331.
- 6.) All power cables inside battery room from battery charger onwards shall be provided with fire proof coating as per IEC-60331.
- 7.) Cable trays, racks and trenches shall be sized to allow for 20 % space for future cables.

### 5.8 EARTHING SYSTEM

| S.No. | Description     | Selected Option  | Available Options |
|-------|-----------------|--|-------------------|
| 1     | Earth electrode | Cu bonded high tensile low carbon steel core electrode |                   |

| S.No. | Description               | Selected Option | Available Options |
|-------|---------------------------|-----------------|-------------------|
| 2     | Main earth loop material  | GI strip        |                   |
| 3     | Substation earth loop     | GI strip        |                   |
| 4     | EHV switchyard earth grid | GI Strip        |                   |

Note:-

- 1.) All earth pits (both earthing & lightning protection) shall be maintenance free chemical earth pits with Cu bonded high tensile low carbon steel core electrode
- 2.) Common clean earth shall be provided for relays, VFD PLC, Thyristor & SAS panels, separate from substation earthing system.

## 5.9 LIGHTING SYSTEM

### 5.9.1 SUPPLY SYSTEM

| S.No. | Description  | Selected Option | Available Options |
|-------|--|-----------------|-------------------|
| 1     | Centralised with Lighting distribution board-LDB       | No              |                   |
| 2     | LDB at each substation                                 | Yes             |                   |
| 3     | Lighting transformer required                          | Yes             |                   |
| 4     | 100% Standby transformer for normal lighting system    | Yes             |                   |
| 5     | 100% Standby transformer for emergency lighting system | Yes             |                   |
| 6     | Lighting transformer voltage ratio                     | 415V/415V       |                   |

### 5.9.2 CONTROL PHILOSOPHY

| S.No. | Description                                   | Selected Option  | Available Options |
|-------|---|--|-------------------|
| 1     | Outdoor yard                                  | Auto/Manual/Local<br>(Respective S/S)                                |                   |
| 2     | Street lighting                               | Auto/Manual/Local<br>(Respective S/S)                                |                   |
| 3     | Outdoor process area                          | Auto/ Manual/ Local<br>(Respective S/S)                              |                   |
| 4     | Process building                              | Auto/ Manual/ Local<br>(Respective S/S)                              |                   |
| 5     | Auto control                                  | Synchronous timer/ECS  |                   |
| 6     | Lamp type for outdoor general lighting        | LED  |                   |
| 7     | Lamp wattage for outdoor lighting (Normal)    | Shall be finalised during detailed engineering                       |                   |
| 8     | Lamp type for emergency AC lighting           | LED  |                   |
| 9     | ELCB at Incomer of Lighting / Power Panels    | Yes(ELCB shall be provided in Outgoing of LDB/ASB)<br>(Refer Note-6) |                   |
| 10    | Switch ON/OFF push button at substation entry | Yes  |                   |

Notes:-

- 1.) Intelligent type synchronous timer shall be provided for control of outdoor lighting.
- 2.) Normal Lighting in substation building shall be contactor controlled with switch at entrance, whereas emergency lighting shall be based on Timer with bypass switch on the switchboard feeder.
- 3.) LED Lamps shall be provided for substation, control room/ SRR and for street lighting.
- 4.) 25% of outdoor general lighting in process area and offsite hazardous area shall be supplied from emergency source.
- 5.) Proximity sensors for normal lighting control shall be provided in Offices and CR/SRR Rack rooms.
- 6.) Combined ELCB + MCB for each lighting outgoing circuit at local lighting distribution panel shall be provided and ELCB shall be rated for 30mA in field and 300mA in indoors.

### 5.9.3 AC EMERGENCY LIGHTING

| S.No. | Description            | Selected Option                                  | Available Options |
|-------|------------------------|--|-------------------|
| 1     | Name of process plants | All process areas (as per operation requirement) |                   |
| 2     | Name of buildings      | Substation, Control room/ SRR                    |                   |
| 3     | Power supply source    | Respective EPCC/ELDB fed from DG                 |                   |

### 5.9.4 DC CRITICAL LIGHTING FOR ESCAPE

| S.No. | Description                      | Selected Option  | Available Options |
|-------|----------------------------------|--|-------------------|
| 1     | Name of process units            | As per specific project requirement  |                   |
| 2     | Name of building                 | Substation, control room, SRR, Administration building/office, FWPH, Fire Station, Compressor House. |                   |
| 3     | Power supply                     | 220V DC  |                   |
| 4     | DC lighting for remote buildings | Lighting fixture with built in battery   |                   |

### 5.9.5 WIRING TYPE

| S.No. | Description                     | Selected Option   | Available Options |
|-------|---------------------------------|---|-------------------|
| 1     | Process plant / Building / Shed | Armoured cable  |                   |
| 2     | Large service building          | Black Enamelled Surface conduit   |                   |
| 3     | Buildings with false ceiling    | Black Enamelled Surface conduit above false ceiling / PVC concealed conduit below false ceiling           |                   |
| 4     | Substation (Switchgear Room)    | Black Enamelled Surface conduit or METSEC above false ceiling / PVC concealed conduit below false ceiling |                   |
| 5     | Substation (Cable Cellar)       | Surface Conduit   |                   |

| S.No. | Description                  | Selected Option  | Available Options |
|-------|------------------------------|--|-------------------|
| 6     | Other buildings in safe area | Black Enamelled surface conduit/ PVC concealed conduit |                   |

Notes:-

- 1.) For lighting in battery rooms, Armoured cables shall be used.

### 5.9.6 SPECIFIC LIGHTING REQUIREMENTS

| S.No. | Description   | Selected Option                             | Available Options |
|-------|---|---|-------------------|
| 1     | Aviation lighting                                   | Yes (LED type, flashing)                    |                   |
| 2     | Security lighting for peripheral road boundary wall | As Required                                 |                   |
| 3     | Type of control gear for HPMV/HPSV lamps            | NA  |                   |
| 4     | Control gear box location                           | NA  |                   |
| 5     | Type of high mast flood light                       | 30 meters Telescopic tubular with LED lamps |                   |

Note:-

- 1.) Level gauge / vessel lamp illumination shall be fed from normal lighting supply.

### 5.10 ELECTRIC HEAT TRACING SYSTEM

| S.No. | Description                  | Selected Option        | Available Options |
|-------|------------------------------|------------------------|-------------------|
| 1     | System Design Basis approach | Product Classification |                   |

Note:-

- 1.) The incoming cable for heat tracing power distribution panel shall be with four cores, the neutral conductor being of same size as the phase conductors.
- 2.) Common alarm from each PDB shall be connected to DCS as a minimum.

### 5.11 ELECTRICAL EQUIPMENT FOR HAZARDOUS AREAS

The electrical equipment for hazardous areas shall be selected as per IS-16724 / IEC 60079-14 and petroleum rules & Gas group shall be selected based on the hazardous area classification. The minimum requirement is summarised below:

| S.No. | Equipment           | Zone-1                         | Zone-2                                    |
|-------|---------------------|--------------------------------|---|
| 1     | MV Motors           | Ex-de*                         | Ex-n#/Ex-nA# (Note-2.9)                   |
| 2     | HV Motors           | Ex-de* / Ex-p (Refer note-2.8) | Ex-n#/Ex-nA#/Ex-de*/Ex-p (Note-2.9, 2.10) |
| 3     | Push Button Station | Ex-d                           | Ex-d                                      |
| 4     | Motor Starters      | Ex-d                           | Ex-d                                      |
| 5     | Plug & Socket       | Ex-d                           | Ex-d                                      |
| 6     | Welding Receptacle  | Ex-d                           | Ex-d                                      |
| 7     | Lighting fitting    | Ex-d                           | Ex-nR                                     |
| 8     | Junction Boxes      | Ex-d                           | Ex-d                                      |
| 9     | Transformer Unit    | Ex-d                           | Ex-d                                      |

| S.No. | Equipment   | Zone-1   | Zone-2   |
|-------|---|--|--|
| 10    | Break Glass Unit<br>(Fire Alarm System)             | Ex-d   | Ex-d   |
| 11    | Lighting Panel / Power<br>Panel                     | Ex-d   | Ex-d   |
| 12    | Transformers  | Hermetically sealed with<br>surface temperature not<br>exceeding 200 DEG C | Hermetically sealed with<br>surface temperature not<br>exceeding 200 DEG C |
| 13    | Auxiliary terminal boxes for<br>sealed canned pumps | Ex-d   | Ex-d   |

\* For all Ex-de equipment, main enclosure of the equipment shall be Ex-d certified and terminal box shall be Ex-e certified.

# Ex-ec motors as per IS/IEC 60079-7 (2015) shall be acceptable subject to availability of statutory approvals.

For additional Hazardous Area requirements, refer notes under clause 5.11.1 below -

### 5.11.1 NOTES

| S.No. | Notes  |
|-------|--|
| 1     | The electrical equipment for hazardous areas shall generally be suitable for gas group IIB and temp classification T3 as applicable to the selected type of explosion protection. In case of hydrogen or hydrocarbon mixtures having more than 30% hydrogen, the gas group to be considered shall be IIC.  |
| 2     | As additional safety features, the following requirements for electrical equipment shall be followed.  |
| 2.1   | All electric motors for agitators/mixers and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as zone 2 or zone 1.  |
| 2.2   | All electric motors for vertical sump pumps handling flammable material shall be flameproof type.  |
| 2.3   | Irrespective of the area classification (whether zone 1 or zone 2), all lighting fixtures within the storage areas shall be flameproof type.   |
| 2.4   | Irrespective of the area classification (whether zone 1 or zone 2), all motors and lighting fittings within the pump house/pump station/compressor house/other facilities associated with offsite tank farm and within the loading/unloading gantries shall be of flameproof type.   |
| 2.5   | All emergency/critical lighting fixtures and associated junction boxes in hazardous areas (whether zone-1 and zone-2) shall be flameproof type.  |
| 2.6   | Even though fired heaters in process units are not considered for area classification, all electrical equipments associated with fired heaters in process units shall as a minimum be suitable for installation in Zone-2 area.  |
| 2.7   | Building such as Compressor sheds inside the process area shall be designed to allow adequate ventilation to allow area classification as Zone-2. Lighting equipment, EOT crane etc. in the shed shall be flameproof type. All other electrical equipment shall be suitable for Zone-1 or Zone-2 area depending on extent of hazard.                   |
| 2.8   | All motors for hazardous area Zone-1 shall preferably be flameproof type. Pressurised motors may be provided in exceptional cases, when flameproof motors are not available.   |
| 2.9   | Ex-n motors shall be used unless any other type is specified by process licensor, except for following cases:<br>(i) HV motors in Zone-2 area for centrifugal compressors shall be flameproof type.<br>(ii) Flameproof motors shall be used in zone-2 areas having frequent start-stop requirements such as EOT cranes, elevators, MOV actuators, etc. |

| S.No. | Notes  |
|-------|--|
| 2.10  | Ex-p motors shall be used for higher rated motors where Ex-n motors are not available.   |
| 2.11  | Cooling Tower fan motors and light fittings shall be flameproof type.  |
| 2.12  | Irrespective of area classification, all canned motors shall be of flameproof type only.   |
| 2.13  | For areas with hazardous dust (Zone-21 & 22), motors with enclosure "tD" or "pD" shall be provided.  |
| 3     | Statutory Approval<br>1. Statutory Authority for Electrical Installation: State Electrical Inspectorate/CEA<br>2. Statutory authority for hazardous area: PESO |

## 5.12 ELECTRICAL CONTROL SYSTEM-ECS

| S.No. | Description   | Selected Option   | Available Options |
|-------|---|---|-------------------|
| 1     | Extent of coverage                                      |   |                   |
| 1.1   | No of substations                                       | All   |                   |
| 1.2   | Monitoring  |   |                   |
| 1.2.1 | EHV/HV switchboard                                      | Yes   |                   |
| 1.2.2 | 415V switchboard (I/C, B/C & outgoing breaker feeders)  | Yes (Upto PCC level)  |                   |
| 1.2.3 | Emergency DG set  | YES (Common Alarm Contact)                                      |                   |
| 1.3   | Control   |   |                   |
| 1.3.1 | EHV/HV switchboard                                      | Yes   |                   |
| 1.3.2 | 415V switchboard (I/C, B/C & outgoing breaker feeders)  | Yes (Upto PCC level)  |                   |
| 1.3.3 | Emergency DG set  | No  |                   |
| 2     | Base ECS functionalities                                |   |                   |
| 2.1   | Breaker control in CPP & Switchyard                     | ON/OFF control for motor feeders, ON/OFF for all other breakers |                   |
| 2.2   | Breaker control in other substations                    | ON/OFF control for all feeders                                  |                   |
| 2.3   | Area lighting   | ON/OFF control  |                   |
| 2.4   | Electrical plant data acquisition and display           | Yes   |                   |
| 2.5   | Routine log report generation and energy balance report | Yes   |                   |
| 2.6   | Detection and reporting of alarms                       | Yes   |                   |
| 2.7   | Sequence of event recording                             | Yes   |                   |
| 3     | Advanced ECS functionalities                            |   |                   |
| 3.1   | Load shedding including maximum demand limit control    | Yes   |                   |
| 3.2   | Synchronization   | Yes   |                   |
| 3.3   | Capacitor feeder control for power factor improvement   | Local APFC in each substation                                   |                   |
| 3.4   | Active & Reactive power control                         | NA  |                   |

| S.No. | Description  | Selected Option                         | Available Options |
|-------|--|---|-------------------|
| 3.5   | Frequency & load control of all generators except DG | NA                                      |                   |
| 3.6   | Excitation control of synchronous motors             | NA                                      |                   |
| 3.7   | Grid transformer OLTC control                        | YES (through discreet DI/DOs)           |                   |
| 4     | Communication with other systems                     | Refer communication requirements in SAS |                   |

Notes :

@- details to be finalised during detail engineering.

- 1.) All the UPS and Battery Charger status & trouble alarms shall be configured in ECS.
- 2.) All the critical and large capacity VFD alarms/trips should be monitored in ECS over serial link.
- 3.) Temperature & humidity monitoring for each substation and connected battery charger room/VFD room shall be provided with display and 4-20mA transmitter for interface with ECS.
- 4.) Refer note-2 of clause 5.4.1 for closing operation of Incomer & Bus coupler breaker through ECS

## 6.0 SPARE PARTS

### 6.1 MANDATORY SPARES

Mandatory spares shall be procured along with the main equipment. Such spares for each equipment shall be as per the below table. These spares include only those spares, which are critical for equipment.

| S.No. | Part Description                            | Description  |
|-------|---|--|
| 1     | Generator                                   | NA (Below Clauses Not Applicable)  |
| 1.1   | Generator relay                             | 1 set of each type & make  |
| 1.2   | DVR - all control card                      | 1 no. of each type   |
| 1.3   | Control fuses / MCB                         | 10 Nos. of each rating & type  |
| 1.4   | Exciter Diodes and fuses                    | 1 set  |
| 1.5   | Control and Selector switches               | 1 No. of each type and make  |
| 1.6   | Aux. contactors                             | 20% of each type and make OR 1 No.(min) of each type and make, whichever is more |
| 2     | EHV & HV Gas Insulated Switchboard (GIS)    |  |
| 2.1   | Portable gas filling equipment/SF6 gas cart | 1 No.  |
| 2.2   | Handle for disconnect switch drive          | 4 Nos.   |
| 2.3   | Handle for earthing switch drive            | 4 Nos.   |
| 2.4   | Pre selection key for three position switch | 1 No.  |
| 2.5   | Power cable termination kit                 | 2 sets   |
| 2.6   | Tripping coil                               | 1 No.  |
| 2.7   | Closing coil                                | 1 No.  |
| 2.8   | Capacitive type voltage detectors           | 1 Set  |
| 2.9   | Control fuses / MCB                         | 10 Nos. of each rating & type  |
| 2.10  | Density monitoring device                   | 2 Nos of each type   |
| 2.11  | Pressure Gauge                              | 2 Nos of each type   |
| 2.12  | Indicating lamps covers                     | 5 nos. of each colour  |

| S.No. | Part Description   | Description   |
|-------|--|---|
| 2.13  | Indicating lamps   | 20% or 3 nos. (min.), whichever is more                                   |
| 3     | Power Transformer  | one set of spare for each transformer                                     |
| 3.1   | Complete set of gaskets  | 1 set   |
| 3.2   | Sealing / Gauge glass of Conservator   | 2 Nos of each rating & type.  |
| 3.3   | Control fuses / MCB for MB cubicles  | 20% for each rating OR 1 No. (min.) of each rating, whichever is more     |
| 3.4   | HV bushings  | One set of each type and rating   |
| 4     | Distribution Transformer   | one set of spare for each transformer                                     |
| 4.1   | Complete set of gaskets  | 1 set   |
| 4.2   | Sealing / Gauge glass of Conservator   | 2 Nos. of each rating & type.   |
| 4.3   | Control fuses / MCB for MB cubicles  | 20% for each rating OR 1 No. (min.) of each rating, whichever is more     |
| 4.4   | HV & LV bushings   | One set of each type and rating   |
| 5     | HV Air Insulated Switchboard (AIS)   | one set of spare for each switchboard (Refer Note-7)                      |
| 5.1   | Closing coil   | 1 No. of each rating & type   |
| 5.2   | Shunt trip coil  | 1 No. of each rating & type   |
| 5.3   | Control fuses / MCB  | 10 Nos. of each rating & type   |
| 5.4   | Indicating lamps covers  | 5 Nos. of each colour   |
| 5.5   | Indicating lamps   | 20% or 3 Nos. (min.), whichever is more                                   |
| 6     | 415V PCC/PMCC/EPCC or MV Switchboard   | one set of spare for each switchboard                                     |
| 6.1   | Closing coil   | 1 No. of each rating & type   |
| 6.2   | Shunt trip coil  | 1 No. of each rating & type   |
| 6.3   | Control fuses / MCB  | 10 Nos. each rating & type  |
| 6.4   | Indicating lamps covers  | 5 Nos. of each colour   |
| 6.5   | Indicating lamps   | 20% or 3 Nos. (min.), whichever is more                                   |
| 7     | Variable Frequency Drive   | one set of spare for each VFD   |
| 7.1   | Transistors / IGBT / IGCT  | 1 No of each rating & type  |
| 7.2   | Control cards  | 1 No of each type   |
| 7.3   | Power supply cards   | 1 No of each rating & type  |
| 7.4   | Power fuses  | 20% for each rating OR 1 no. (min.) of each rating, whichever is more     |
| 7.5   | Control fuses / MCB  | 10 Nos. of each rating & type   |
| 7.6   | Contactors   | 10% of each type OR 1 no. (min) of each type, whichever is more           |
| 7.7   | Indicating lamps   | 20% OR 1 nos. (min.), whichever is more                                   |
| 7.8   | Indicating lamps covers  | 2 nos of each colour  |
| 7.9   | Blocker Diode  | 2 nos. of each rating & type  |
| 8     | Substation Automation System (SAS) / HMI / Data Concentrator                     | one set of spare for each SAS / HMI / Data Concentrator                   |
| 8.1   | All cards such as input & output cards, power supply cards, processor cards etc. | 1 No. of each type  |
| 8.2   | Ethernet switches  | 1 No. of each type  |
| 8.3   | Control fuses / MCB  | 10 Nos. of each rating & type   |
| 9     | Relays for Switchboard / Relay control Panel                                     | one set of spare for each Switchboard (Refer Note-8)/ Relay control Panel |
| 9.1   | Protection Relays  | 1 No. of each type  |
| 9.2   | Auxiliary Relays   | 1 No. of each type  |
| 10    | UPS System   | one set of spare for each UPS system                                      |

| S.No. | Part Description                               | Description  |
|-------|--|--|
| 10.1  | Power Thyristors / Transistors / IGBT / IGCT   | 1 No. of each rating & type  |
| 10.2  | Control cards                                  | 1 No. of each type   |
| 10.3  | Power supply cards                             | 1 No. of each rating and type  |
| 10.4  | Power fuses                                    | 20% for each rating OR 1 no. (min.)of each rating, whichever is more                       |
| 10.5  | Control fuses / MCB                            | 10 Nos. of each rating & type  |
| 10.6  | Indicating lamps                               | 10% OR 3 nos. (min.), whichever is more  |
| 10.7  | Indicating lamps covers                        | 2 Nos. of each colour  |
| 10.8  | Blocker Diode                                  | 2 Nos. of each rating & type   |
| 11    | DC System                                      | one set of spare for each DC System  |
| 11.1  | Power Thyristors / Transistors / IGBT / IGCT   | 1 No. of each rating & type  |
| 11.2  | Control cards                                  | 1 No. of each type   |
| 11.3  | Power supply cards                             | 1 No. of each rating and type  |
| 11.4  | Power fuses                                    | 20% for each rating OR 1 no. (min.)of each rating, whichever is more                       |
| 11.5  | Control fuses / MCB                            | 10 Nos. of each rating & type  |
| 11.6  | Indicating lamps                               | 10% OR 3 nos. (min.), whichever is more  |
| 11.7  | Indicating lamps covers                        | 2 Nos. of each colour  |
| 11.8  | Blocker Diode                                  | 2 Nos. of each rating & type   |
| 12    | Synchronous motors                             | one set of spare for each rating & type  |
| 12.1  | Power fuses                                    | 20% for each rating OR 1 no. (min.)of each rating, whichever is more                       |
| 12.2  | Control fuses / MCB                            | 10 Nos. of each rating & type  |
| 12.3  | Bearing ( DE & NDE ) (as applicable)           | 1 set  |
| 12.4  | Control cards                                  | 1 No. of each type   |
| 13    | HV induction motors                            | one set of spare for each rating & type  |
| 13.1  | Bearing ( DE & NDE )                           | 1 set  |
| 13.2  | Terminal studs/bushing assembly                | 1 set each   |
| 14    | MV induction motors 37 kW & above              | one set of spare for each rating & type  |
| 14.1  | Bearing ( DE & NDE )                           | 1 set  |
| 14.2  | Terminal studs/bushing assembly                | 1 set each   |
| 15    | Fire alarm system                              |  |
| 15.1  | All cards                                      | 1 No. of each type   |
| 15.2  | Power fuses                                    | 20% for each rating OR 1 no. (min.)of each rating, whichever is more                       |
| 15.3  | Control fuses / MCB                            | 10 Nos. of each rating & type  |
| 15.4  | Terminal blocks                                | 20 Nos   |
| 15.5  | Fire Detectors                                 | 1% of total installed capacity of each type OR 1 no.(min.) of each type, whichever is more |
| 15.6  | Glass for Break Glass Boxes/ Manual call point | 5 % of each type OR 1 No. (min.) of each type, whichever is more                           |
| 16    | Paging system / Plant Communication System     |  |
| 16.1  | All cards                                      | 1 No of each type  |
| 16.2  | Power fuses                                    | 20% for each rating OR 1 no. (min.)of each rating, whichever is more                       |
| 16.3  | Control fuses / MCB                            | 10 Nos. each rating & type   |
| 17    | Thyristor control panel for heaters            |  |

| S.No. | Part Description  | Description  |
|-------|---|--|
| 17.1  | Rectifier control module (Control card fully assembled) | 1 No. of each type   |
| 17.2  | Power supply card                                       | 1 No. of each type   |
| 17.3  | Control cards   | 1 No of each type  |
| 17.4  | Power fuses   | 2 Nos. min. of each rating and type  |
| 17.5  | Control fuses / MCB                                     | 10 Nos. each rating & type   |
| 17.6  | Contactors  | 10% of each type OR one no (min) of each type, whichever is more                                       |
| 17.7  | Indicating lamps  | 20% OR 1 nos. (min.), whichever is more  |
| 17.8  | Indicating lamps covers                                 | 2 nos. of each colour  |
| 17.9  | Blocker Diode   | 2 nos. of each rating & type   |
| 18    | Electrical Control System (ECS)                         |  |
| 18.1  | Interposing relays (As applicable)                      | 5 Nos. of each type  |
| 18.2  | Power supply & control cards                            | 1 No. of each type   |
| 18.3  | Transducers   | 20% of estimated quantity of each type and make OR 1 no (min) of each type and make, whichever is more |
| 18.4  | Function generator cum counter                          | 1 No.  |
| 18.5  | 4-20mA signal injection set                             | 1 No.  |
| 18.6  | Isolation transformer                                   | 1 No.  |
| 19    | Motor Operated Valves (MOVs)                            |  |
| 19.1  | Position transmitter                                    | 10% (1 no. min. if the same is provided in MOVs)   |
| 19.2  | Power supply unit                                       | 10% (1 no. min.)   |
| 19.3  | Logic Board   | 10% (1 no. min.)   |
| 19.4  | Local control board assembly                            | 10% (1 no. min.)   |
| 19.5  | Switchgear assembly                                     | 10% (1 no. min.)   |
| 19.6  | Complete motor assembly                                 | 1 no of each rating  |

**NOTES:**

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. Wherever % age is identified, Contractor shall supply next rounded figure.
3. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Mandatory spares as indicated above do not cover commissioning spares.
5. Mandatory spares as indicated above do not cover two year O&M spares.
6. Mandatory spares shall be applicable for electrical items of motors / sub-packages as per mandatory spares philosophy specified elsewhere in the bid document.
7. For Isolation breaker panel (GIS or AIS) one set of "Tripping Coil (1 No.), Closing coil (1 No.) and Control fuse/MCB (10 Nos. of each rating and type)" shall be considered as mandatory spares for each Isolation breaker panel (GIS or AIS).
8. For Isolation breaker panel (GIS or AIS) one set of "Auxiliary relays (1 no. of each type)" shall be considered as mandatory spares for Relays for Isolation breaker panel (GIS or AIS).

**6.2 COMMISSIONING SPARES**

Commissioning Spare Parts shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended spares shall be obtained along with the offer.

**6.3 RECOMMENDED SPARE FOR NORMAL OPERATION & MAINTAINENCE**

Quotation for two-years spares for normal operation and maintenance (over and above mandatory spares) along with unit price shall be obtained with the proposal for Client to order the same separately.

#### **6.4 SPECIAL TOOLS AND TACKLES**

Required Special Tools and Tackles shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended special tools/tackles shall be obtained along with the offer.

#### **7.0 VENDOR DATA REQUIREMENT**

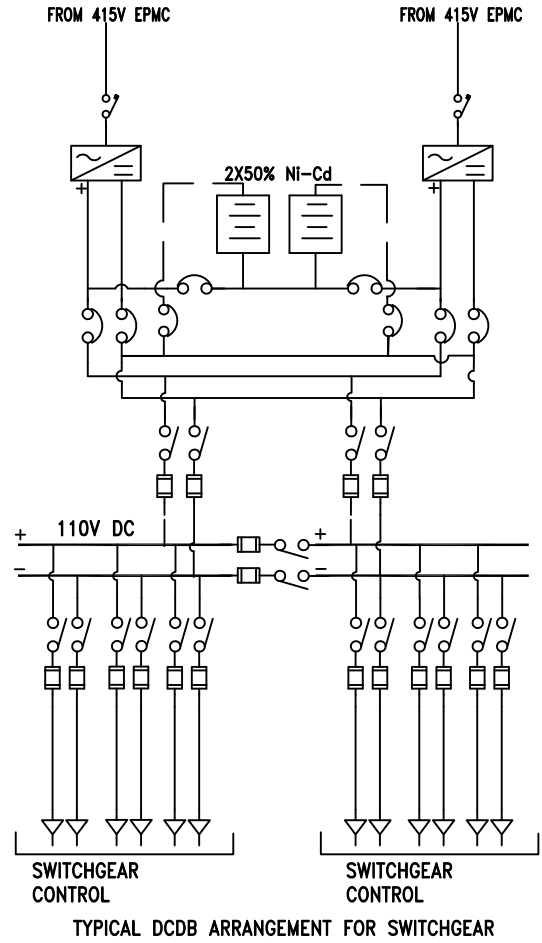
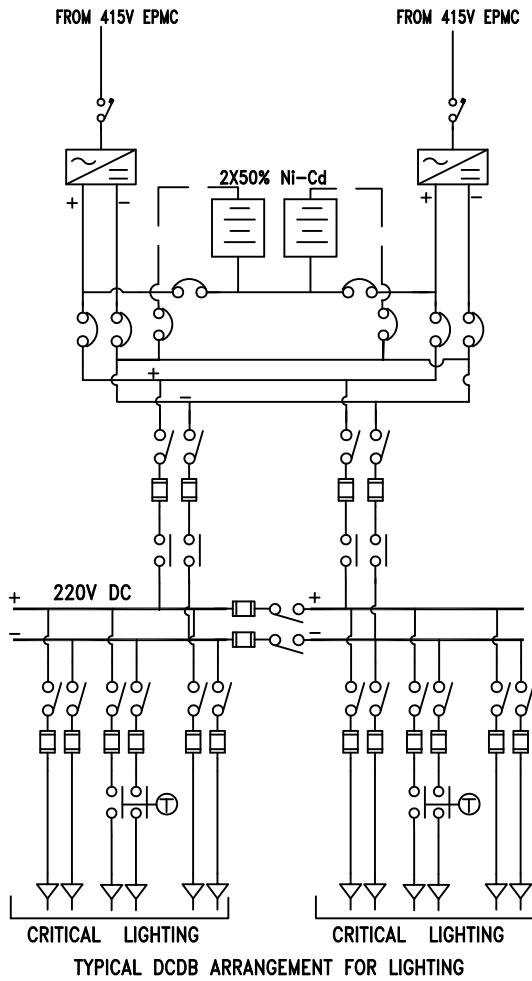
Vendor Data Requirement as indicated in the respective equipment Material Requisitions shall be followed.

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PROJECT: P25 PROJECT

CLIENT: M/s IOCL

| REV | DATE | PURPOSE | BY | CHKD | APPD |
|-----|------|---------|----|------|------|
|     |      |         |    |      |      |



1. DCDB FOR DC SYSTEM SHALL HAVE TWO NO. INCOMER AND ONE NO. BUS COUPLER.
2. DCDB FOR DC SYSTEM FOR DC CRITICAL LIGHTING SHALL HAVE CONTACTOR IN THE INCOMER FOR OPERATING UNDER AC MAINS SUPPLY FAILURE CONDITION AND CONTACTOR IN OUTDOOR TYPE CRITICAL LIGHTING FEEDER FOR OPERATING AS PER THE TIMER SETTING.
3. BATTERY CHARGER AND BATTERY FOR DC SYSTEM SHALL BE AS PER SPECIFICATION ATTACHE WITH MR.
4. '\*' REFER MR FOR VOLTAGE LEVEL OF DCDB

Annexure-1



**ENGINEERS INDIA LIMITED**  
NEW DELHI

**TYPICAL BUS BAR  
ARRANGEMENT FOR DCDB  
(FOR DC SYSTEM)**

**SKETCH**

**REV**

B269-999-16-50-SK-XXXX  
SHT 1 OF 1

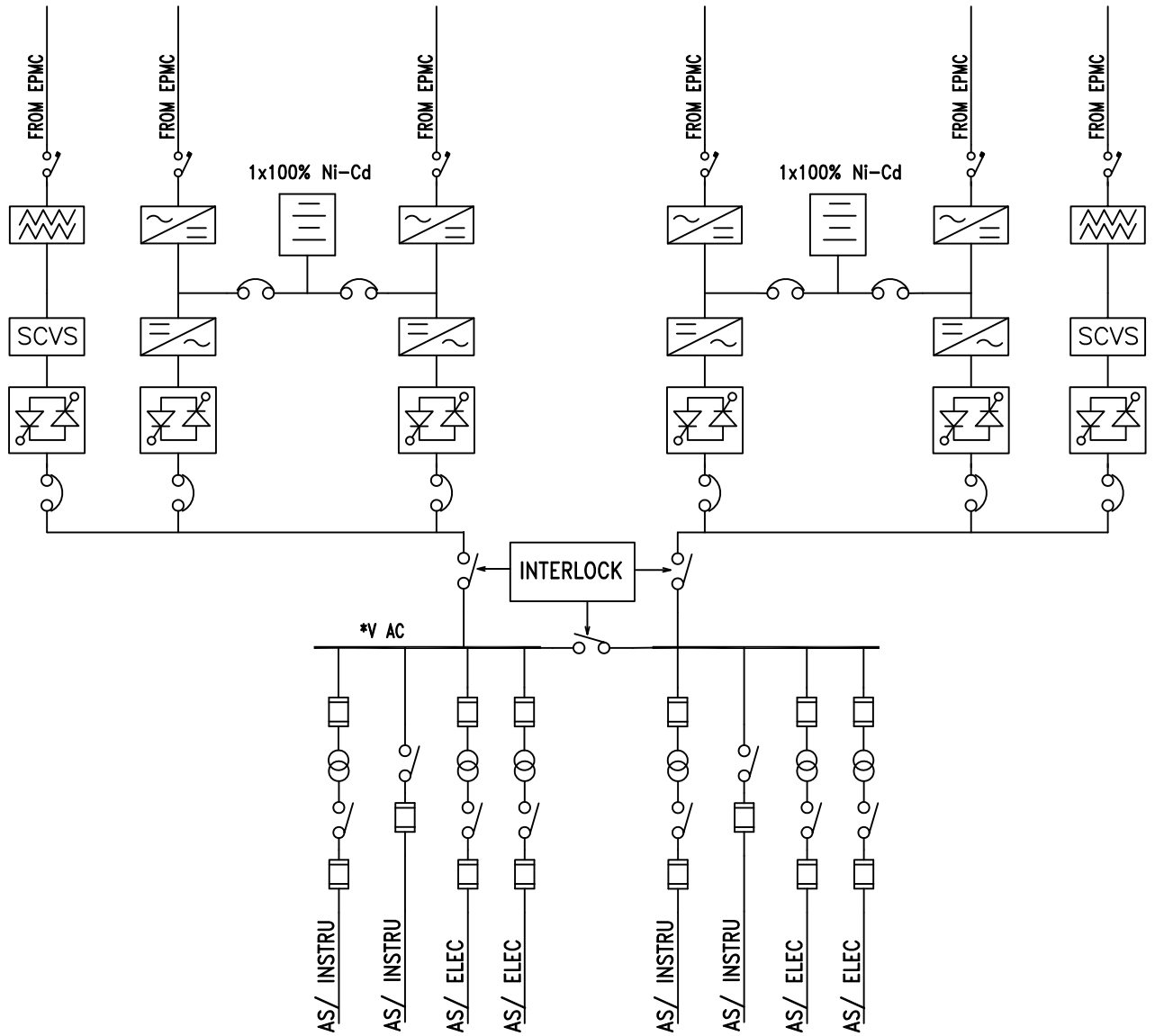
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PROJECT: P25 PROJECT

CLIENT: M/s IOCL

| REV | DATE | PURPOSE | BY | CHKD | APPD |
|-----|------|---------|----|------|------|
|     |      |         |    |      |      |



**TYPICAL ACDB ARRANGEMENT  
UPS SYSTEM**

1. ACDB SHALL HAVE TWO NO. INCOMER AND ONE NO. BUS COUPLER.
2. BATTERY CHARGER AND BATTERY FOR UPS SHALL BE AS PER JOB SPECIFICATION.
3. FOR VOLTAGE AND CURRENT RATING OF ACDB AND OUTGOING COMPONENTS REFER RESPECTIVE FEEDER DETAILS DATASHEET.
4. EACH UPS MODULE (RECTIFIER/INVERTER SET) SHALL BE RATED FOR 100% RATING OF THE UPS.

Annexure-2



**ENGINEERS INDIA LIMITED**  
NEW DELHI

**TYPICAL UPS & ACDB  
ARRANGEMENT**

**SKETCH**

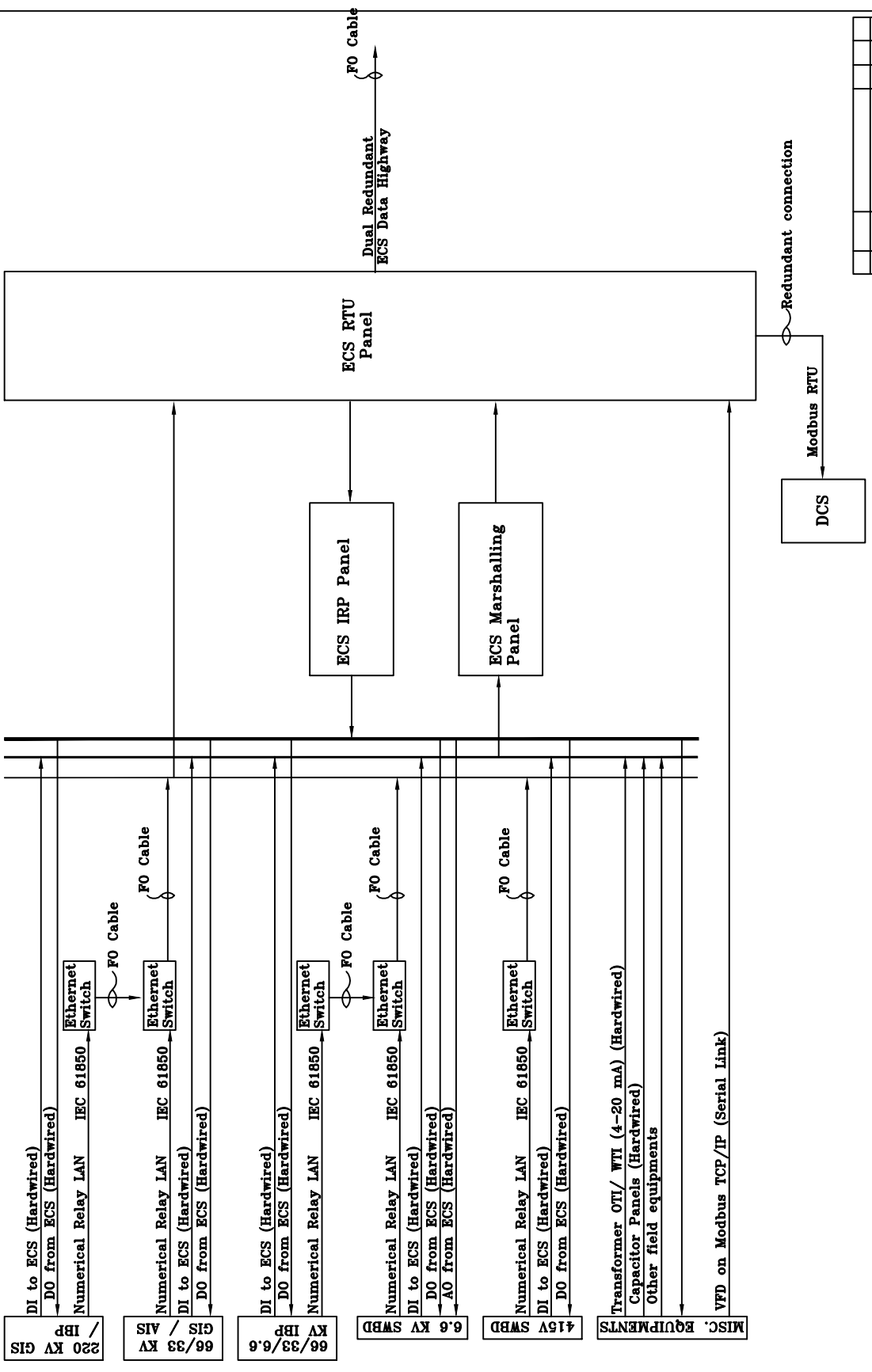
**REV**

B269-999-16-50-DS-XXXX  
SHT 1 OF 1

X

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A4-210X297



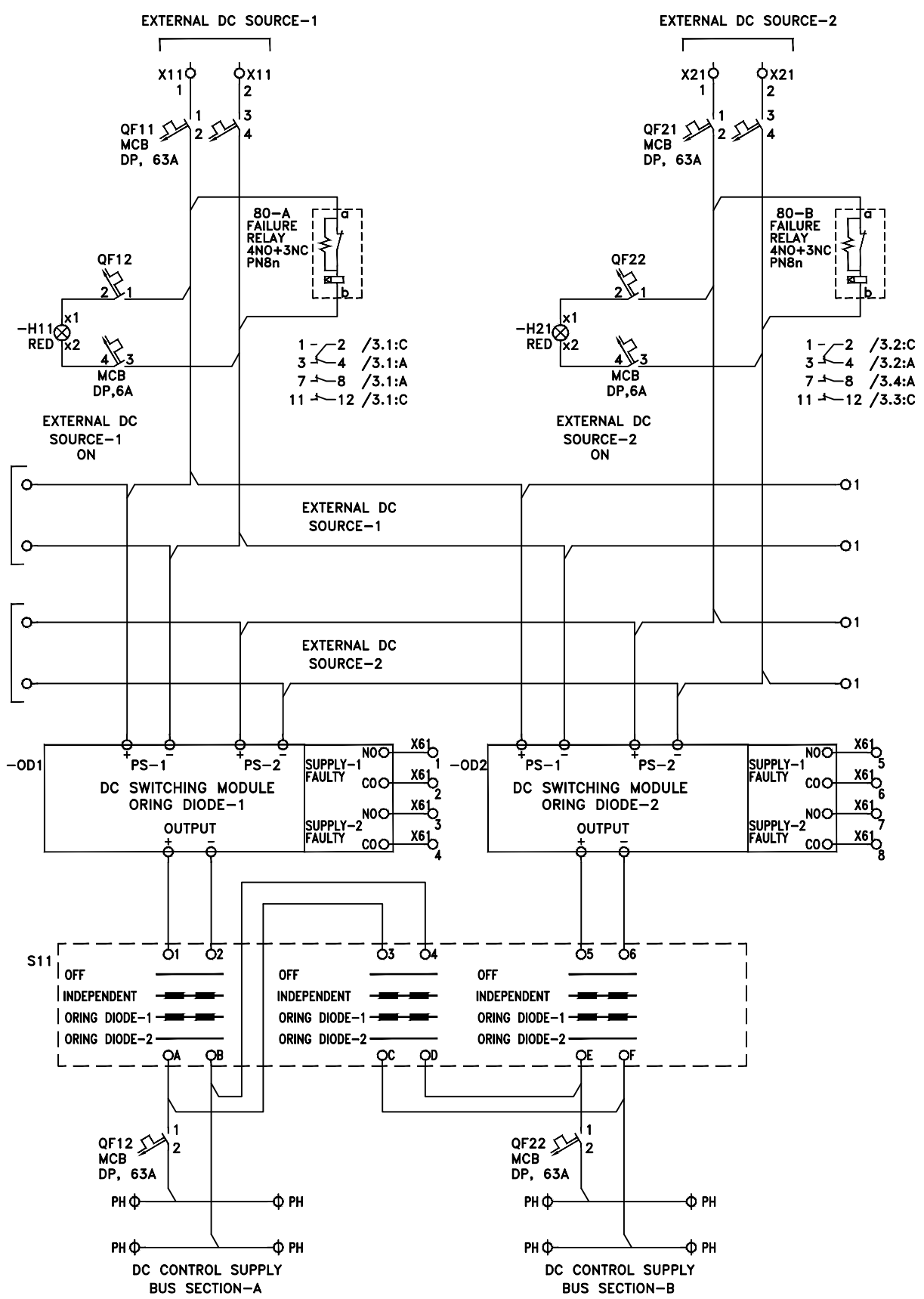
| No | DATE | REVISION | BY | CHK | APP |
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|    |      |          |    |     |     |
|    |      |          |    |     |     |
|    |      |          |    |     |     |

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PROJECT: P25 PROJECT

CLIENT: M/s IOCL

| REV | DATE | PURPOSE | BY | CHKD | APPD |
|-----|------|---------|----|------|------|
|     |      |         |    |      |      |



Annexure-4



ENGINEERS INDIA LIMITED  
NEW DELHI

DC SUPPLY  
AUTO CHANGEOVER  
FOR SWBD

SKETCH

REV

B269-999-16-50-SK-XXXX  
SHT 1 OF 1

X

# SECTION-2, Annexure\_2

## INSPECTION AND TEST PLAN FOR EHV GIS SWITCHBOARDS


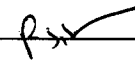
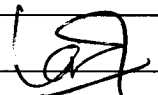
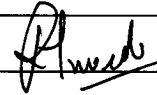
STANDARD SPECIFICATION NO.

6-81-1066 Rev. 0

Page 1 of 10

अति उच्च वोल्टेज गैस इंसुलटेड स्विचबोर्डों के लिये  
निरीक्षण और परीक्षण योजना

## INSPECTION AND TEST PLAN FOR EHV GAS INSULATED SWITCHBOARDS (GIS)

| Rev. No. | Date       | Purpose                   | Prepared by   | Checked by  | Standards Committee<br>Convenor  | Standards Bureau<br>Chairman   |
|----------|------------|---------------------------|---|---|--|--|
| 0        | 12.09.2018 | Issued for implementation | <br>MM | <br>RS | <br>RKS | <br>RKT |
|          |            |                           | Approved by   |   |  |  |

**Abbreviations:**

|      |   |  |             |   |   |
|------|---|--|-------------|---|---|
| BIS  | : | Bureau of Indian Standard                  | IP          | : | Ingress Protection                            |
| CT   | : | Current Transformer                        | IR          | : | Insulation resistance                         |
| CRP  | : | Control Relay Panel                        | JEC         | : | Japanese Electro technical Committee          |
| EHV  | : | Extra High Voltage                         | KV          | : | Kilo Volt                                     |
| EIL  | : | Engineers India Limited                    | LCC         | : | Local Control Panel                           |
| EMC  | : | Electromagnetic Compatibility              | MTC         | : | Material Test Certificate                     |
| ERTL | : | Electronics Regional Test Laboratory       | NEMA        | : | National Electrical Manufacturers Association |
| FAT  | : | Factory Acceptance Test                    | PO          | : | Purchase Order                                |
| FR   | : | Fire Retardant                             | PR          | : | Purchase Requisition                          |
| FRLS | : | Fire Retardant Low smoke                   | PVC         | : | Poly Vinyl Chloride                           |
| GIS  | : | Gas Insulated Switchgear                   | QC          | : | Quality Control                               |
| HT   | : | High Tension                               | TC          | : | Test Certificate                              |
| HV   | : | High Voltage                               | TPI or TPIA | : | Third Party Inspection Agency                 |
| HMI  | : | Human Machine Interface                    | VDR         | : | Vendor Data Requirement                       |
| ITP  | : | Inspection and Test Plan                   | VT          | : | Voltage Transformer                           |
| IEC  | : | International Electro technical Commission | XLPE        | : | Cross Linked Poly Ethylene                    |

**Inspection Standards Committee****Convenor :** Mr. R K Singh

**Members:** Mr. Rajeev Kumar  
 Mr. Neeraj Mathur  
 Mr. Mahendra Mittal  
 Mr. Deepak Gupta (Projects)

Mr. Himangshu Pal  
 Mr. R Muthu Ramalingam  
 Mr. T Kamalakannan

**1.0 SCOPE**

This Inspection and Test Plan covers the minimum testing requirements of Extra High Voltage Gas insulated Switch boards (EHV GIS) from 66 KV and up to 400 KV.

**2.0 REFERENCE DOCUMENTS**

PO/PR/ Standards referred therein/ Job specifications/ Approved documents/ Relevant IEC.

**3.0 INSPECTION AND TEST REQUIREMENTS**

| SL NO. | STAGE/ ACTIVITY  | CHARACTERISTICS   | QUANTUM OF CHECK | RECORD   | SCOPE OF INSPECTION |          |          |
|--------|--|---|------------------|--|---------------------|----------|----------|
|        |  |   |                  |  | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
| 1.0    | <b>Procedures</b>  | --  | --               | --   | --                  | --       | --       |
| 2.0    | <b>Material Inspection</b>   |   |                  |  |                     |          |          |
| 2.1    | Incoming Material like Basic HT kit with Circuit Breaker/ Disconnecter and Earthing Switches, SF6 Gas Properties, Checks On Tank, Plating of Joints, Bus Bars, Fabricated Items, Static Filters, Safety Diaphragm, Pressure Relief Devices, Valves, Expansion Bellows, Pipe Fittings, Bus Bar Sleeves, Cable Wire (FRLS), Instrument Transformers, Relays, Indicating Instruments, Switches, | Visual, Dimensional, Operational/performance checks, Review of Manufacturer's Certificates etc. as applicable | 100%             | TC's/ Inspection & Test Records / Lab Test Records | H                   | H/R      | R        |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

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| SL NO.     | STAGE/ ACTIVITY  | CHARACTERISTICS   | QUANTUM OF CHECK  | RECORD  | SCOPE OF INSPECTION |          |          |
|------------|--|---|---|---|---------------------|----------|----------|
|            |  |   |   |   | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
|            | Breakers, Surge Arrestor , Hooters, Push Button etc. as applicable |   |   |   |                     |          |          |
| <b>3.0</b> | <b>In process Inspection</b>                                       |   |   |   |                     |          |          |
| 3.1        | Breaker Truck Assembly   | <ul style="list-style-type: none"> <li>Mechanical Operation including spring charging mechanism (current and time) / electro hydraulic mechanism (As applicable), Breaker opening / closing at normal and worst voltage conditions, Stroke, Opening / closing time and speed, bouncing time, simultaneous closing of all poles, Contact resistance measurement, Gas leakage check (for SF6 breakers), Insulation resistance test, High voltage/ Power Frequency, partial discharge test</li> <li>Breaker Duty cycle test</li> </ul> | <p>100% by Supplier and random by EIL/TPIA</p> <p>On each type/ model</p> | <p>Test Records / Inspection Witness Record</p> <p>Type Test Report</p> |                     | H        | H        |
|            |  |   |   |   |                     | H        | R        |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

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| SL NO. | STAGE/ ACTIVITY                    | CHARACTERISTICS   | QUANTUM OF CHECK                        | RECORD                                   | SCOPE OF INSPECTION |          |          |
|--------|------------------------------------|---|---|--|---------------------|----------|----------|
|        |                                    |   |   |  | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
| 3.2    | Disconnecter and earthing switches | <ul style="list-style-type: none"> <li>Visual checks.</li> <li>Mechanical and electrical operation including mechanical and electrical interlocks</li> <li>Contact resistance measurement.</li> <li>Insulation resistance test.</li> <li>High voltage/Power frequency test.</li> </ul>  | 100% by Supplier and random by EIL/TPIA | Test Records / Inspection Witness Record |                     | H        | H        |
| 3.3    | Wiring checks                      | Size, type, make termination, ferruling, continuity, color coding   | 100%                                    | Suppliers Test Records                   | --                  | H        | R        |
| 4.0    | <b>Final Inspection</b>            |   |   |  |                     |          |          |
|        |                                    | <b>ACCEPTANCE TESTS:</b> <ul style="list-style-type: none"> <li>Visual check including layout, Tag plates, Paint shade, Bus marking and sleeving, Joint shrouding, Earthing arrangement, safety features, accessibility of arcing contact, Identification and location of components etc</li> <li>Dimension check including operational height, Bus bar size, Clearances, Head room from gland</li> </ul> |   |  |                     |          |          |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

6-81-1066 Rev. 0

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| SL NO. | STAGE/ ACTIVITY     | CHARACTERISTICS  | QUANTUM OF CHECK | RECORD   | SCOPE OF INSPECTION |          |          |
|--------|---------------------|--|------------------|--|---------------------|----------|----------|
|        |                     |  |                  |  | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
| 4.1    | Switchgear Assembly | plate to terminal link, mounting arrangement for CTs, VTs<br>Compartmentalization, cable gland size, Paint thickness etc.  | 100%             | Test Records /<br>Inspection<br>Witness Record | -                   | H        | H        |
|        |                     | <ul style="list-style-type: none"> <li>• Verification of Bus bar support arrangement with respect to type tested panel drawings and provision for external cable termination.</li> <li>• Bill of material check.</li> <li>• Density/pressure switches indication /operation checks.</li> <li>• Operation check of circuit breaker operation counters.</li> <li>• Mechanical/Electrical interlock checks of Circuit breaker/Isolator/earthing switches *</li> <li>• Operation check for auxiliary equipment circuits and auxiliary contacts</li> <li>• Operation checks for all control functions and interlocks as per schematic diagrams in Service position including mechanical interlock check.</li> </ul> | 100%             | Test Records /<br>Inspection<br>Witness Record | -                   | H        | H        |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

6-81-1066 Rev. 0

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| SL NO. | STAGE/ ACTIVITY                 | CHARACTERISTICS  | QUANTUM OF CHECK | RECORD | SCOPE OF INSPECTION |          |          |
|--------|---------------------------------|--|------------------|--------|---------------------|----------|----------|
|        |                                 |  |                  |        | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
|        | Switchgear Assembly<br>(Contd.) | <ul style="list-style-type: none"> <li>• Functional/operation checks on LCC panel including alarm, indication, annunciation, mimic diagram display etc.</li> <li>• Functional/ operation checks on CRP panel including alarm, indication, annunciation, mimic diagram display, relays, auxiliary contact etc.</li> <li>• HV and IR checks on LCC &amp; CRP panel.</li> <li>• Relay operation check through secondary injection.*</li> <li>• Primary current injection test for all current and voltage transformers.*</li> <li>• Measurement of resistance of main circuit.</li> <li>• Communication check between relays and Data concentrator / HMI (if applicable)*</li> <li>• HMI operation and functional checks as per separate agreed ITP/FAT (if applicable)</li> <li>• Insulation resistance of main, auxiliary and control circuits</li> </ul> |                  |        |                     |          |          |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

6-81-1066 Rev. 0

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| SL NO. | STAGE/ ACTIVITY     | CHARACTERISTICS  | QUANTUM OF CHECK   | RECORD              | SCOPE OF INSPECTION |          |          |
|--------|---------------------|--|--------------------|---------------------|---------------------|----------|----------|
|        |                     |  |                    |                     | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
|        |                     | before and after High Voltage Test.<br><ul style="list-style-type: none"> <li>• Power Frequency voltage withstand test on main, auxiliary and control circuits.</li> <li>• Partial discharge test</li> <li>• Enclosure pressure test and Leak Tightness checks.</li> <li>• Acceptance test on SF6 Gas *</li> </ul>   |                    |                     |                     |          |          |
| 4.2    | Switchgear Assembly | <b>TYPE TESTS</b> <ul style="list-style-type: none"> <li>• Short time current withstand test on main and earthing circuit.</li> <li>• Temperature Rise test.</li> <li>• Internal Arc test.</li> <li>• Lighting Impulse, Switching impulse, Power Frequency withstand Test and partial discharge test( Di electric test)</li> <li>• Making and breaking capacity test of circuit breaker</li> <li>• Short circuit test duties for Circuit breaker.</li> <li>• Tightness test and pressure withstand test for gas filled compartment.</li> </ul> | On Each type/Model | Test Agency Reports | -                   | R/W**    | R/W**    |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

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| SL NO.     | STAGE/ ACTIVITY                           | CHARACTERISTICS   | QUANTUM OF CHECK   | RECORD                | SCOPE OF INSPECTION |          |          |
|------------|---|---|--------------------|-----------------------|---------------------|----------|----------|
|            |   |   |                    |                       | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
|            |   | <ul style="list-style-type: none"> <li>• Operation and mechanical endurance test</li> <li>• Degree of protection for panels.</li> <li>• Electromagnetic compatibility (EMC) test on circuit breaker</li> </ul>  |                    |                       |                     |          |          |
|            | <b>Disconnecter and Earthing switches</b> | <p style="text-align: center;"><b>TYPE TEST</b></p> <ul style="list-style-type: none"> <li>• Operation and mechanical endurance test</li> <li>• Short time and peak withstand capacity test.</li> <li>• Measurement of contact resistance</li> <li>• Temperature rise test</li> <li>• Impulse and power frequency withstand test</li> <li>• Electromagnetic compatibility test</li> <li>• Degree of protection test.</li> </ul> | On Each type/Model | Test Agency Reports   | -                   | R/W**    | R/W**    |
|            | <b>Surge arrestor, CT,PT</b>              | <ul style="list-style-type: none"> <li>• Type test as per relevant IEC</li> </ul>   | On Each type/Model | Test Agency Reports   | -                   | R/W**    | R/W**    |
| <b>5.0</b> | <b>Painting</b>                           |   |                    |                       |                     |          |          |
| 5.1        | Painting of panels (prior to assembly)    | <ul style="list-style-type: none"> <li>• Pre treatment, primer and final paint, shade, thickness</li> </ul>   | 100%               | Supplier test records | H                   | W        | R        |

**INSPECTION AND TEST PLAN  
FOR  
EHV GIS SWITCHBOARDS**

STANDARD SPECIFICATION NO.

6-81-1066 Rev. 0

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| SL NO. | STAGE/ ACTIVITY           | CHARACTERISTICS   | QUANTUM OF CHECK | RECORD   | SCOPE OF INSPECTION |          |          |
|--------|---------------------------|---|------------------|--|---------------------|----------|----------|
|        |                           |   |                  |  | SUB SUPPLIER        | SUPPLIER | EIL/TPIA |
| 6.0    | Documentation and IC      |   |                  |  |                     |          |          |
| 6.1    | Documentation and IC      | <ul style="list-style-type: none"> <li>Review of Internal Test Reports</li> <li>Certification from supplier for complete relay parameterization of numerical relays at works</li> <li>IC issuance.</li> </ul> | 100%             | Supplier's Test Records / Inspection Certificate | -                   | -        | H        |
| 6.2    | Final Document submission | Compilation of Inspection reports, drawings, etc. as per VDR / PR   | 100%             | Final data folder/ Completeness certificate      | -                   | H        | H        |

\* Quantum of check is 100% by Supplier & random basis by EIL/TPIA.

\*\* Witness if called for in job specifications. In such cases specified Type test will be considered as part of Acceptance Test.

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

**NOTES :-**

- This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
- Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred therein/ Job specifications /Approved documents.

# SITE SPECIFIC SEISMIC SPECTRA

PROJECT : P-25 PANIPAT REFINERY EXPANSION PROJECT

OWNER : M/s IOCL

JOB NO. : B269

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| Rev. No | Date       | Purpose                   | Prepared by | Reviewed by | Approved by |
|---------|------------|---------------------------|-------------|-------------|-------------|
| 0       | 03/12/2020 | ISSUED FOR IMPLEMENTATION | MBA         | GGSA        | SVRS        |

## SITE SPECIFIC SEISMIC SPECTRA

Site specific seismic spectrum is generated separately for Design Basis Earthquake (DBE) & Maximum Considered Earthquake (MCE) for different damping values in accordance with Clause no. 3.5 and Clause no 3.18 of IS 1893 (Part 4) : 2015 respectively. The spectral accelerations presented here shall be used along with Clause no. 7.3.1 of IS 1893 (Part 4): 2015.

### 1.1 Spectral Acceleration Coefficients ( $S_a/g$ ) for Design Basis Earthquake (DBE):

Spectral Acceleration Coefficients ( $S_a/g$ ) for 5% damping for Design Basis Earthquake (DBE) in the horizontal direction shall be based on the following equation. The spectral acceleration values for different damping ratio are presented in Figure 1 and Table 1.

$$S_a/g \text{ (damping: 5\%)} = 0.16+2.4T \quad \text{for } 0.00 < T < 0.10 \text{ sec}$$

$$= 0.4 \quad \text{for } 0.10 < T < 0.55 \text{ sec}$$

$$= \frac{0.217}{T} \quad \text{for } 0.55 < T < 7.00 \text{ sec}$$

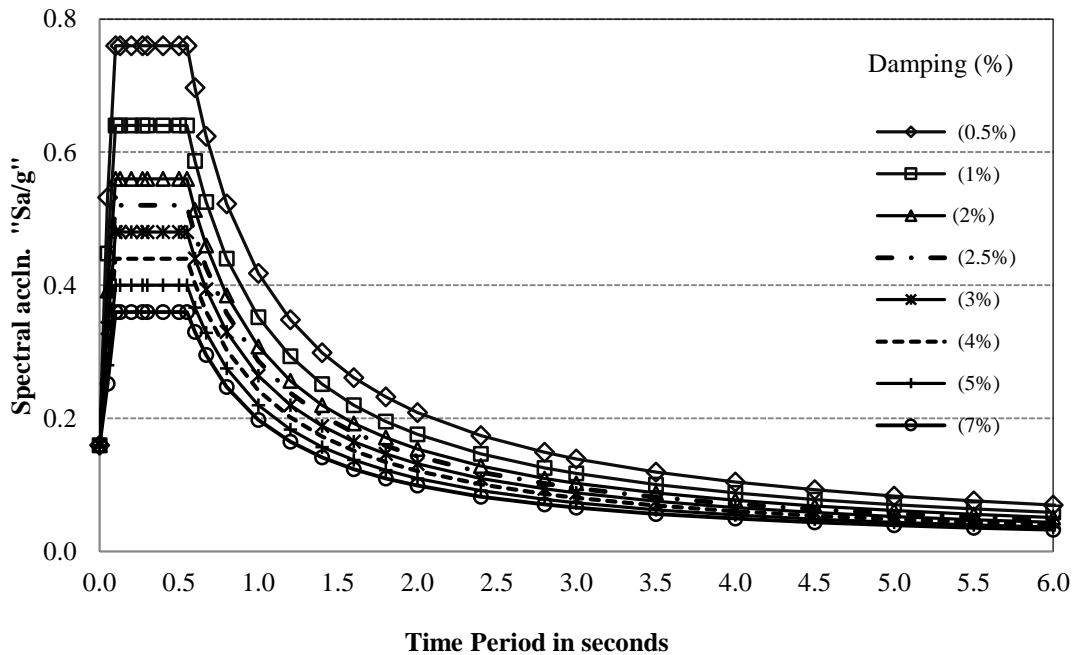


Figure 1: Site specific seismic spectra for DBE

Table 1: Spectral Acceleration Coefficients ( $S_a/g$ ) for Design Basis Earthquake (DBE)

| Time Period (sec) | Percentage of critical damping |       |       |       |       |       |       |       |
|-------------------|--------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                   | 0.5                            | 1.0   | 2.0   | 2.5   | 3.0   | 4.0   | 5.0   | 7.0   |
| 0.000             | 0.160                          | 0.160 | 0.160 | 0.160 | 0.160 | 0.160 | 0.160 | 0.160 |
| 0.050             | 0.532                          | 0.448 | 0.392 | 0.364 | 0.336 | 0.308 | 0.280 | 0.252 |
| 0.100             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.130             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.200             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.270             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.300             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.400             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.500             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.550             | 0.760                          | 0.640 | 0.560 | 0.520 | 0.480 | 0.440 | 0.400 | 0.360 |
| 0.600             | 0.697                          | 0.587 | 0.513 | 0.477 | 0.440 | 0.403 | 0.367 | 0.330 |
| 0.670             | 0.624                          | 0.525 | 0.460 | 0.427 | 0.394 | 0.361 | 0.328 | 0.296 |
| 0.800             | 0.523                          | 0.440 | 0.385 | 0.358 | 0.330 | 0.303 | 0.275 | 0.248 |
| 1.000             | 0.418                          | 0.352 | 0.308 | 0.286 | 0.264 | 0.242 | 0.220 | 0.198 |
| 1.200             | 0.348                          | 0.293 | 0.257 | 0.238 | 0.220 | 0.202 | 0.183 | 0.165 |
| 1.400             | 0.299                          | 0.251 | 0.220 | 0.204 | 0.189 | 0.173 | 0.157 | 0.141 |
| 1.600             | 0.261                          | 0.220 | 0.193 | 0.179 | 0.165 | 0.151 | 0.138 | 0.124 |
| 1.800             | 0.232                          | 0.196 | 0.171 | 0.159 | 0.147 | 0.134 | 0.122 | 0.110 |
| 2.000             | 0.209                          | 0.176 | 0.154 | 0.143 | 0.132 | 0.121 | 0.110 | 0.099 |
| 2.400             | 0.174                          | 0.147 | 0.128 | 0.119 | 0.110 | 0.101 | 0.092 | 0.083 |
| 2.800             | 0.149                          | 0.126 | 0.110 | 0.102 | 0.094 | 0.086 | 0.079 | 0.071 |
| 3.000             | 0.139                          | 0.117 | 0.103 | 0.095 | 0.088 | 0.081 | 0.073 | 0.066 |
| 3.500             | 0.119                          | 0.101 | 0.088 | 0.082 | 0.075 | 0.069 | 0.063 | 0.057 |
| 4.000             | 0.105                          | 0.088 | 0.077 | 0.072 | 0.066 | 0.061 | 0.055 | 0.050 |
| 4.500             | 0.093                          | 0.078 | 0.068 | 0.064 | 0.059 | 0.054 | 0.049 | 0.044 |
| 5.000             | 0.084                          | 0.070 | 0.062 | 0.057 | 0.053 | 0.048 | 0.044 | 0.040 |
| 5.500             | 0.076                          | 0.064 | 0.056 | 0.052 | 0.048 | 0.044 | 0.040 | 0.036 |
| 6.000             | 0.070                          | 0.059 | 0.051 | 0.048 | 0.044 | 0.040 | 0.037 | 0.033 |
| 6.500             | 0.064                          | 0.054 | 0.047 | 0.044 | 0.041 | 0.037 | 0.034 | 0.030 |
| 7.000             | 0.060                          | 0.050 | 0.044 | 0.041 | 0.038 | 0.035 | 0.031 | 0.028 |

**1.2 Spectral Acceleration Coefficients (Sa/g) for Maximum Considered Earthquake (MCE):**

Spectral Acceleration Coefficients (Sa/g) for 5% damping for Maximum Considered Earthquake (MCE) shall be based on the following equation. The spectral acceleration values for different damping ratio are presented in the Figure 2 and Table 2.

$$\begin{aligned}
 S_a/g \text{ (damping: 5\%)} &= 0.24+3.6T && \text{for } 0.00 < T < 0.10 \text{ sec} \\
 &= 0.6 && \text{for } 0.10 < T < 0.67 \text{ sec} \\
 &= \frac{0.326}{T} && \text{for } 0.67 < T < 7.0 \text{ sec}
 \end{aligned}$$

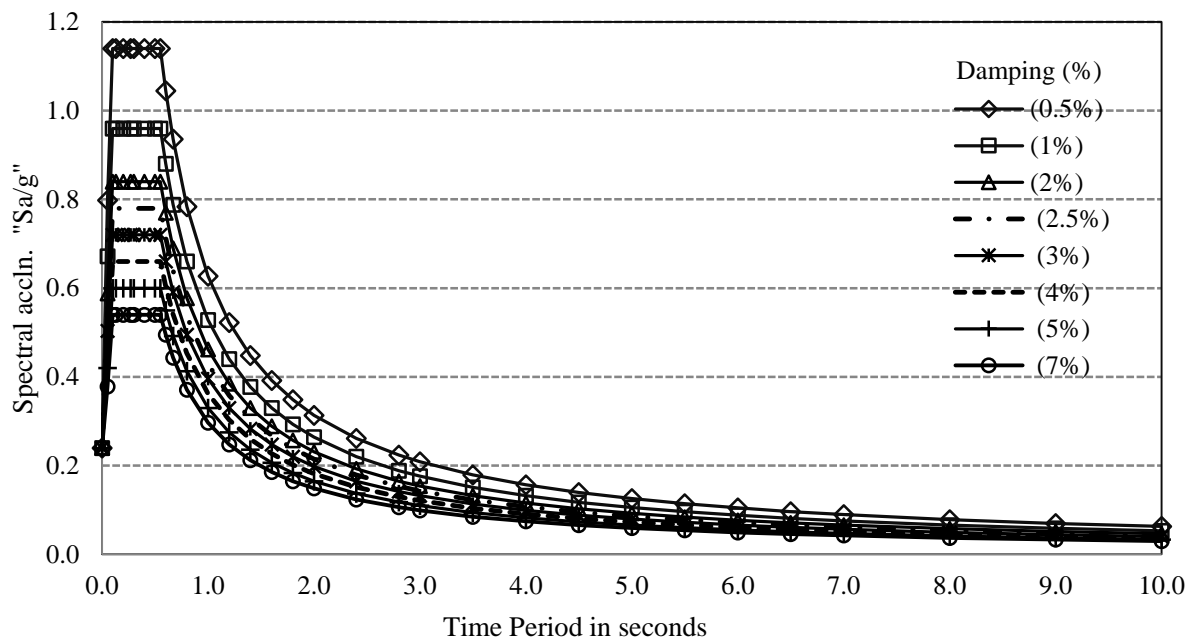


Figure 2: Site specific seismic spectra for MCE

Table 2: Spectral Acceleration Coefficients ( $S_a/g$ ) for Maximum Considered Earthquake (MCE)

| Time Period (sec) | Percentage of critical damping |       |       |       |       |       |       |       |
|-------------------|--------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                   | 0.5                            | 1.0   | 2.0   | 2.5   | 3.0   | 4.0   | 5.0   | 7.0   |
| 0.000             | 0.240                          | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 |
| 0.050             | 0.798                          | 0.672 | 0.588 | 0.546 | 0.504 | 0.462 | 0.420 | 0.378 |
| 0.100             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.130             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.200             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.270             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.300             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.400             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.500             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.550             | 1.140                          | 0.960 | 0.840 | 0.780 | 0.720 | 0.660 | 0.600 | 0.540 |
| 0.600             | 1.045                          | 0.880 | 0.770 | 0.715 | 0.660 | 0.605 | 0.550 | 0.495 |
| 0.670             | 0.936                          | 0.788 | 0.690 | 0.640 | 0.591 | 0.542 | 0.493 | 0.443 |
| 0.800             | 0.784                          | 0.660 | 0.578 | 0.536 | 0.495 | 0.454 | 0.413 | 0.371 |
| 1.000             | 0.627                          | 0.528 | 0.462 | 0.429 | 0.396 | 0.363 | 0.330 | 0.297 |
| 1.200             | 0.523                          | 0.440 | 0.385 | 0.358 | 0.330 | 0.303 | 0.275 | 0.248 |
| 1.400             | 0.448                          | 0.377 | 0.330 | 0.306 | 0.283 | 0.259 | 0.236 | 0.212 |
| 1.600             | 0.392                          | 0.330 | 0.289 | 0.268 | 0.248 | 0.227 | 0.206 | 0.186 |
| 1.800             | 0.348                          | 0.293 | 0.257 | 0.238 | 0.220 | 0.202 | 0.183 | 0.165 |
| 2.000             | 0.314                          | 0.264 | 0.231 | 0.215 | 0.198 | 0.182 | 0.165 | 0.149 |
| 2.400             | 0.261                          | 0.220 | 0.193 | 0.179 | 0.165 | 0.151 | 0.138 | 0.124 |
| 2.800             | 0.224                          | 0.189 | 0.165 | 0.153 | 0.141 | 0.130 | 0.118 | 0.106 |
| 3.000             | 0.209                          | 0.176 | 0.154 | 0.143 | 0.132 | 0.121 | 0.110 | 0.099 |
| 3.500             | 0.179                          | 0.151 | 0.132 | 0.123 | 0.113 | 0.104 | 0.094 | 0.085 |
| 4.000             | 0.157                          | 0.132 | 0.116 | 0.107 | 0.099 | 0.091 | 0.083 | 0.074 |
| 4.500             | 0.139                          | 0.117 | 0.103 | 0.095 | 0.088 | 0.081 | 0.073 | 0.066 |
| 5.000             | 0.125                          | 0.106 | 0.092 | 0.086 | 0.079 | 0.073 | 0.066 | 0.059 |
| 5.500             | 0.114                          | 0.096 | 0.084 | 0.078 | 0.072 | 0.066 | 0.060 | 0.054 |
| 6.000             | 0.105                          | 0.088 | 0.077 | 0.072 | 0.066 | 0.061 | 0.055 | 0.050 |
| 6.500             | 0.096                          | 0.081 | 0.071 | 0.066 | 0.061 | 0.056 | 0.051 | 0.046 |
| 7.000             | 0.090                          | 0.075 | 0.066 | 0.061 | 0.057 | 0.052 | 0.047 | 0.042 |

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NOTES:

1. For methodology of calculation of seismic forces and other seismic design criteria, refer latest revisions of the following codes:  
IS 1893 (Part 1):2016 : General provisions and buildings  
IS 1893 (Part 4):2015 : Industrial structures including stack-like structures
2. All parameters shall be in accordance with the above mentioned codes.
3. Structures/equipment categorized as Category 1 shall also be checked for MCE.
4. For design purpose, spectra shall be considered as per the section 1.1 and 1.2. For any other purpose such as ductile detailing requirement, the site location shall be considered as Zone IV.
5. When cylindrical storage tanks are designed as per API 650/620 using site-specific design methods, the percentage of critical damping and response reduction shall be taken in accordance with the respective design codes.

# SECTION-3

## *GENERAL TECHNICAL REQUIRMENTS (Part- B)*

### **1.0 GENERAL**

- 1.1 This section stipulates the general technical requirements under the contract and will form integral part of the technical specification.
- 1.2 The provisions under this specification are intended to supplement requirement for the materials, equipments and services covered under this specification and is not exclusive. However, in case of conflict between requirements specified in this section and requirements specified in other sections the requirements specified- under respective sections shall hold good.

### **2.0 INSTRUCTION TO BIDDERS**

- 2.1 The bidders shall submit the technical requirements, data and information as per the technical specifications provided in the bid documents.
- 2.2 The bidders shall furnish catalogues, engineering data, technical information, design document, drawings etc fully in conformity with the technical specification.
- 2.3 It is recognised that the contractor may have standardised on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the owner. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously; All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.
- 2.4 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the technical specifications unless include in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard shall be deemed to be included in the scope of the specification. All similar standard components/parts of similar standard equipment provided, shall be inter changeable with one another.
- 2.5 Unless brought out clearly in the respective schedule of deviations, it will be considered that, the bid proposal scrupulously confirms compliance to the specification. The bidder must bring out all the deviations in the bid proposal.
- 2.6 In case there is a discrepancy between the data offered equipment and catalogue furnished, and unless the deviations are brought out clearly in the Technical Deviation Schedule, the equipment will be deemed to conform compliance to the specification scrupulously.

### **3.0 STANDARDS**

- 3.1 The works covered by the specification shall be designed, engineered, manufactured, built tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.
- 3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments of standard specified of this section as well as under respective Sections/Chapters of the specification.
- 3.3 In addition to meeting the specific requirement called for in the respective sections of the Technical Specification, the equipment shall also conform to the general requirement of the relevant standards and shall form an internal part of the specification.
- 3.4 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intend to compliment each other.
- 3.5 The Contractor shall also note that list of standards presented in this specification is not complete. Wherever necessary the list of standards shall of the specification shall take precedence.
- 3.6 When the specific requirements stipulated in the specification exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.
- 3.7 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted.
- 3.8 In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in deviation sheets along with English language version of standard or relevant shall be subject to Owner's approval.

#### **4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

- 4.1 The 220/33 kV system is being designed to limit the switching surge over voltage and the power frequency over voltage within limits of IEC. The equipment furnished under this specification shall perform all its functions and operate satisfactorily with out showing undue strain, re-strike etc. under such over voltage conditions and in system where line lengths would extend up to 200 km.
- 4.2 All equipments shall also perform satisfactorily under various Electro-mechanical and meteorological conditions of the site of installation.
- 4.3 All the Equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, short circuit etc for the equipment.
- 4.4 The bidder shall design the various forces for terminal connectors of the equipment are required to withstand.
- 4.5 The equipment shall also comply to the following:
  - All outdoor EHV equipments shall be suitable for hot line washing.
  - To facilitate erection of equipment, all items to be assembled as site shall be "match marked".
  - All piping, if any between equipment control cabinet operating mechanism to marshalling box of the equipment shall bear proper identification to facilitate the connection at site.

#### **5.0 ENGINEERING DATA**

- 5.1 The furnishing of engineering data by the Contractor shall be in accordance with the schedule for each set of equipment as specified in the technical specifications.
- 5.2 The review of these data by the owner will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the owner may not indicate a through review of all dimensions, quantities and accuracy of the information submitted. This review and/or approval by the owner shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviation from the requirements, specified under these specifications and documents.
- 5.3 All engineering data submitted by the Contractor after final process including review and approval by the owner shall from part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the owner in Writing.
- 5.4 LIST OF DOCUMENTS
  - 5.4.1 The bidder must furnish a detailed list of drawings/documents along with the bid proposal which he intends to submit to the owner after awarded of the contract.
  - 5.4.2 The supplier shall necessarily submit all the drawings/ documents unless anything is waived. The supplier shall submit required sets of drawings/design documents/test reports as may be required for the approval of the owner.
  - 5.4.3 All engineering data submitted by the Contractor after final process including review and approval by the Owner shall from part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the owner in Writing.
- 5.5 DRAWINGS
  - 5.5.1 All drawing submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearances and spaces required for installation and interconnection between various portions of equipments and any other information specifically requested in the specifications.
  - 5.5.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Owner, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
  - 5.5.3 Further work by the Contractor shall be in strict accordance with these drawing and no deviation shall be permitted without the written approval of the Owner if so required.

5.5.4 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Owner. Approval of Contractor's drawing or work by the Owner shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.5.5 APPROVAL PROCEDURE

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Owner would be discussed and finalised at the time of award. The supplier shall also submit six (6) copies of all drawings/design documents/test report for approval of the Owner. The following tentative schedule shall be followed in general for approval. However final schedule shall be prepared with approval of Engineer in-charge post award of approval.

|   |  |   |
|---|--|---|
| 1 | Submission, comments, resubmission and approval by recommended agency (As listed in Section/Chapter-1) | Within 4 weeks of receipt   |
| 2 | Approval/comments/by Owner on initial submission   | Within 4 weeks of receipt.  |
| 3 | Resubmission   | Within 3 (three) weeks (whenever from date of comments required) including both ways postal time. |
| 4 | Approval or comments   | Within 3 weeks of receipt of  |
| 5 | Furnishing of distribution copies  | weeks from the date of last approval.   |

NOTE:

The contractor may please note that all resubmission must incorporate all comments given in the submission by the Owner failing which the submission of documents is likely to be returned.

5.6 The drawing which are required to be referred frequently during execution should be submitted on cloth lined paper.

5.7 OTHER REQUIREMENTS OF DOCUMENTATION

5.7.1 One set of soft copy of all drawings, manual, catalogs to be submitted along with 6 sets of hardcopies during submission of as built documents.

- 5.7.2 6 copies of instruction/operation manuals for complete project shall also be furnished. The instruction Manuals shall contain full details of drawing of all equipment being supplied under this contract, their exploded diagrams with complete instruction for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures
- 5.7.3 If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manual in the form of one (1) reproducible original and twelve (12) copies shall be submitted by the Contractor to the Owner.

The Contractor shall furnish to the Owners, twelve (12) sets of spare part catalogue.

## **6.0 COLOUR SCHEME AND CODES**

- 6.1 The contractor shall propose parts a color scheme for the those equipments /Items for which the colour scheme has not been specified in the specification, for the approval of Owner. The decision of Owner shall be final. The scheme shall include:

- Finishing colour of Indoor equipment.
- Finishing colour of Outdoor equipment.
- Finishing colour of all cubicals.
- Finishing colour of various auxiliary system equipment including piping.
- Finishing colour of various building items.

- 6.2 All steel structures, plates etc shall be hot dip galvanised or painted with noncorrosive paint on a suitable primer as per the provisions of the respective Section. It may be noted that normally all Owner's electrical equipment in Owner's switchyard are painted with shade 631 of IS-5 and Owner will prefer to follow the same for this project also. All the indoor cubicles shall be of same colour scheme and for other miscellaneous items colour scheme will be approved by the Owner.

## **7.0 MATERIAL/ WORKMANSHIP**

### **7.1 GENERAL REQUIREMENTS**

- 7.1.1 Where the specification does not contain characteristics with reference to workmanship, equipment, materials and component of the covered Equipment, it is understood that the same must be new, of highest ,grade of the best quality of their kind, conforming to the best engineering practice and suitable for the purpose for which they are intended.
- 7.1.2 The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of ardent in accordance with purpose for which they are intended and to ensure satisfactory performance throughout the service life.

- 7.1.3 In case where the equipment, material or components are indicated in the specification as "similar" to any special standard, the Owner shall decide upon the question of similarity. When required by the specification or required by the Owner the supplier shall submit, for approval, all the information concerning the material or components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Supplier.
- 7.1.4 The design of the work shall be such that installation, future expansions, replacement and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All joints and fastenings shall be devised; constructed and documented so that the component part shall be accurately positioned and retained to fulfil their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Owner.
- 7.1.5 Whenever possible, all similar parts of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same material and workmanship as the corresponding parts of the equipment supplied under specification. Where feasible, common component units shall be employed in different pieces of the equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
- 7.1.6 All material and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). The erection procedure must be approved by the OEM and erection completion shall be certified by OEM for satisfactory completion. The commissioning of all major equipments as recommended by Engineer in-charge.
- 7.1.7 Only first-class work in accordance with the best modern practice will be accepted. Installation shall be constructed as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouping, leveling, aligning, coupling of or bolting down to previously installed equipment bases/foundation, performing the alignment check and final adjusting prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances and instruction and the specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and/or moving machine parts and shall be designed for easy installation and removal for maintenance purpose. The spare equipment(s) shall be installed at designated location and tested for healthiness.
- 7.1.8 The Supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purpose shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Supplier shall apply all operational lubricants to the equipment installed by him.
- 7.1.9 All oil, grease and other consumable used in the Works/Equipment shall be purchased in India unless the Supplier has any special requirement for the specific application of a type of oil or grease not available in India. In such a case he shall declare in the proposal, where such oil or grease is available. He shall help Owner in establishing equivalent India make and Indian supplier. The same shall be applicable to other consumable too.

7.1.10 A cast iron or welded steel base plate shall be provided for all rotating equipment which are to be installed on a concrete base unless otherwise agreed to by the Owner. Each base plate shall support the units and its drive assembly, shall be of design with pads for anchoring the units and shall have a raised up all around and shall have threaded in air connections, if so required.

## 7.2 PROVISION FOR EXPOSURE TO HOT HUMID CLIMATE

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipments located in non- air conditioned areas shall also be same type.

### 7.2.1 SPACE HEATERS

7.2.1.1 The heater shall be suitable for continuous operation at 240 V as supply voltage. On-off switch and fuse shall be provided.

7.2.1.2 One or more adequately rated permanently or thermostatically connected heater shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connection shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation. This shall be demonstrated by tests.

7.2.1.3 The heaters shall be suitably designed to prevent any contact between the heater wire and the air and shall consist of coiled resistance wire centered in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties, or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air. Alternately, they shall consist of a resistance wire mounted into a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heater shall be restricted wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

### 7.2.2 FUNGISTATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied to parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### 7.2.3 VENTILATION OPENING

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass or galvanized steel to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

#### 7.2.4 DEGREE OF PROTECTION

The enclosures of the control cabinets, junction boxes and marshalling boxes to be installed shall provide degree of protection as detailed here under:

a) Installed outdoor: IP 55

b) Installed indoor in air conditioned area :IP31

c) Installed in covered area : IP 52

d) Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP 41

The degree of protection shall be in accordance with IS: 13947(Part-I) or IEC-947 (part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

The above requirement is indicative only. Requirements as provided in respective technical specification shall prevail.

### 8.0 RATING PLATES, NAME PLATES AND LABELS

8.1 Each main and auxiliary item of substation is to be permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading condition under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Owner. The rating plates of each equipment shall be according to IEC requirement.

8.2 All such nameplates instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other English Instruction may be provided.

### 9.0 FIRST FILL OF CONSUMABLE, OIL AND LUBRICANT

All the first fill consumable such as SF6, AC refrigerant, oil, lubricant, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful operation, shall be supplied by the Contractor unless specification excluded under the exclusions in these specifications and documents

### 10.0 DESIGN IMPROVEMENTS

10.1 The bidder may note that the equipments offered by him in the bid only shall be acceptable, however, the Purchaser or the Supplier may propose changes in the specification of the equipment or quality thereof and if the parties agreed upon any such changes, the specification shall be modified accordingly.

10.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of the completion before the contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

## **11.0 QUALITY ASSURANCE PROGRAMME**

11.1 To ensure that the equipment and services under the scope of this contract whether manufactured or performed within the contractor's Work or at his Subcontractor's premises or at the Owner's site or at any other place of work are in accordance with the specification, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary.

Such programme shall be outlined by the contractor and shall be finally accepted by the Owner after discussions before award of contract. A quality assurance programme of the contractor shall generally cover the following:

- a) His Organization structure for the management and implementation of the proposed quality assurance programme:
- b) Qualification data for bidder's key personnel:
- c) Documentation control System:
- d) The procedure for purchases of material, parts components and selection of subcontractor's services including vendor analysis, source, inspection, incoming raw material inspection, verification of material purchases etc:
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly control:
- f) Control and non-conforming items and system for corrective actions:
- g) Inspection and test procedure both for manufacture and field activities:
- h) Control of calibration and testing of measuring instruments and field activities:
- i) System for indication and appraisal of inspection status:
- j) System for quality audits:
- k) System for authorising release of manufactured product to the Purchaser:
- l) System for maintenance of records:
- m) System for handling storage and delivery: and
- n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services ordered.

The Owner or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

## 11.2 QUALITY ASSURANCE DOCUMENTS

The contractor shall be required to submit the following quality Assurance Documents within three weeks after despatch of the equipment.

All Non-destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and report including radiography interpretation reports.

Welder identification list, listing welder's and welding operator qualification procedure and welding identification symbols.

Welder and Welding operator qualification certificate.

Raw material test reports on components as specified by the specification and for agreed to in the quality plan.

Stress relief time temperature chart/oil impregnation tile temperature chart.

Factory test results for testing required as per applicable codes/ mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points(CAP) as mutually agreed and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

## 12.0 INSPECTION, TESTING & INSPECTION CERTIFICATE

- 12.1 The Owner his duly authorised representative and/or outside inspection agency acting on behalf of the Owner shall have at all reasonable times free access to the Contractor's premises or Works and shall have the power at all reasonable times to inspect and examine the material and the Workmanship of the Works during its manufacture or erection and if part of the works during its manufacturing or erection and if the part of works being manufactured or assembled at other premises or works, the contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the work were manufactured or assembled on the Contractor own premises or works, Inspection may be made at any stage of manufacture, despatch or at site at the option of the Owner and equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- 12.2 All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with relevant standards.
- 12.3 The Contractor shall give the Owner/Inspector thirty (30) days written notice of any material being ready for testing along with work test certificate. Such tests shall be to the Contractor's account. The Owner unless witnessing of the tests is virtually waived, will attend such tests with thirty (30) days of the date of which the equipment is notified as being ready for tests/inspection, the contractor must ensure TPI for all inspections in line with tender documents.
- 12.4 The Owner or Inspector shall, within fifteen (15) days from the date of inspection as defined here in give notice in writing to the contractor, of any objection to any drawings and all any equipment and workmanship which in his opinion is not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either made the modifications that may be necessary to meet the said objections or shall confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

- 12.5 When the, factory tests have been completed at the Contractor's or Subcontractor's Works the Owner/Inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should, it, on further tests after erection be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of dispatch clearances in approved by the Owner.
- 12.6 In all cases where the Contract provides for tests whether at the premises or at the works of the contractor or of any Sub-Contractor. The Contractor except where otherwise specified shall provide free of charge such items as labour, material electrically, field water, stores, apparatus and instruments as may be reasonably demanded by the Owner/Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the contractor and shall give facilities to the Owner/ Inspector or to his authorised representative to accomplish testing.
- 12.7 The inspection by Owner and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the contractors.
- 12.8 The Owner will have the right of having at his own expenses any other test(s) of Reasonable nature carried out at Contractor premises or at site of in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.
- 12.9 The Owner reserves the right for getting any field tests conducted on the completely assembled equipment at site.

## **13.0 TESTS**

### **13.1 CHARGING**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at site. The list of pre-commissioning tests to be performed are given in section-7 and shall be included in the Contractor's quality assurance programme.

### **13.2 COMMISSIONING TESTS**

- 13.2.1 The available instrumentation and control equipment will be used during such tests shall calibrated. However un-measurable parameters shall be taken into account in a reasonable manner by the Owner for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Owner will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified condition.
- 13.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- 13.2.3 The specified tests to be conducted on equipment have been brought out in the respective chapters of the technical specification.

13.2.4 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However, necessary fee shall be paid by Owner.

#### **14.0 PACKING AND SHIPPING**

All the equipment shall be suitably protected, coated, covered or boxes and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Owner takes no responsibility of the wagons.

#### **15.0 PROTECTION**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pilings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

#### **16.0 PAINTING AND FINISHING OF METAL SURFACES**

##### **16.1 GENERAL**

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro-galvanized to service condition. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS: 2629.

##### **16.2 HOT DIP GALVANIZING**

16.2.1 The minimum weight of the zinc coating shall be 610g/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM.

16.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel; The finished surfaces shall be clean and smooth and shall be free from defects liked is colour patches, are spots, unevenness of coating, plate which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects notices on visual or microscopic inspection shall render the material liable to rejection.

16.2.3 After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

- 16.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.
- 16.2.5 Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the standard price test. All other coating shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
- Coating
  - Uniformity of zinc
  - Adhesion test
  - Mass of Zinc
- 16.2.6 Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

### **16.3 PAINTING**

- 16.3.1 All sheet steel work shall be digressed, pickled, phosphated in accordance with the IS-6005 "code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall before hand to be treated and protected for the life of the equipment. The surface which are to be finished painted after installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swart shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- 16.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and over drying. The phosphate coating shall be sealed with application of two coats may be "flash dried" while the second coat shall be stoved.
- 16.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.
- 16.3.4 The exterior color of the paint shall be as per shade No.:631 of IS-5 and inside shall be glossy white. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.
- 16.3.5 In case the bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc. the procedure shall be submitted along with the bids for Owner's review & approval.

### **17.0 HANDLING, STORING AND INSTALLTION**

- 17.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Owner or his representative, the contractor shall unload, store, erect, install, wire test and place into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

- 17.2 Contractor may engage manufacturer's engineer to supervise the unloading, transportation to site, storing and erection. The contractor shall engage the manufacturer's Engineer's for testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s)/ as per Manufacturer's approved process and shall extend full cooperation to them.
- 17.3 In case of any doubt or misunderstanding as to the correct interpretation of manufacture's drawing or instruction, necessary clarifications shall be obtained from the Owner/ Manufacturer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawing/instructions correctly.
- 17.4 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between section including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected during testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- 17.5 Supplier shall be responsible for examining all the shipment and notify the Owner immediately of any damage, shortage, discrepancy etc. for the purpose of Owner's information only. The supplier shall submit to the Owner every week a report detailing all the receipts for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Supplier.
- 17.6 The Contractor shall be fully responsible for the equipment material unit the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment material while in storage as well as after erection unit taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 17.7 Where material/equipment is unloaded by Owner before the Contractor arrives at site or even when he is at site. Owner by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- 17.8 The Supplier shall be responsible for making suitable indoor storage facilities, to store all equipment which require indoor storage.
- 17.9 The words 'erection' and 'installation' used in the specification are synonymous.
- 17.10 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 17.11 The minimum phase to earth, phase to phase and section clearance for the various 132 kV, 66 kV and 33 kV sections of the switchyard are given below:

|                     | 220 kV | 132 kV | 33 kV |
|---------------------|--------|--------|-------|
| Phase to earth (mm) | 2100   | 1300   | 320   |
| Phase to Phase (mm) | 2100   | 1600   | 350   |

|                        |      |      |      |
|------------------------|------|------|------|
| Section clearance (mm) | 5000 | 4000 | 2800 |
|------------------------|------|------|------|

The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life.

## **18.0 PROTECTIVE GUARD**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/ or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

## **19.0 DESIGN CO-ORDINATION**

- 19.1 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinate performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done so that it facilitates easy field assembly and maintenance.
- 19.2 The Contractor has to coordinate designs and termination with the agencies (If any) who are LSTK vendors/ Contractor for the Owner if applicable. The names of agencies shall be intimated to the successful bidders.

## **20.0 DESIGN CO-ORDINATION MEETING**

The Contractor will be called upon to attend design co-ordination meeting with the Engineer, other Contractor's and the LSTK vendors of Owner (If any) during the period of Contract. The Contractor shall attend such meeting at his own cost as and when required and fully cooperate with such person and agencies involved during those discussions.

## **21.0 TOOLS AND TACKELS**

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

## **22.0 EQUIPMENT BASES**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Owner. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

## **23.0 SUPPORT STRUCTURE**

- 23.1 The support structures should be hot dip galvanised with minimum 610 gram/m<sup>2</sup> net of Zinc.
- 23.2 In case of any deviation in this regard the bid is liable to be rejected.
- 23.3 Support structure shall meet the following mandatory requirements.

- 23.4 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 meters or as per applicable standard.
- 23.5 The design calculations taking into account the environmental conditions of the substations shall be furnished for sizing of the structures.

**24.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS**

24.1 All power clamps and connectors shall conform to IS:5561 & NEMA CC1 and shall be made of materials listed below:

|    |   |   |
|----|---|---|
| a) | For connecting ACSR Conductors  | Aluminium alloy casting conforming to designation A6 of IS:617 and shall be tested for all test as per IS:617   |
| b) | For connecting equipment terminals made of copper with ACSR conductors              | Bimetallic connectors made from aluminium alloy casting, conforming to designation A6 of IS 617 with 2mm thick bimetallic liner and shall tested as per IS:617                            |
| c) | For connecting GI shield wire   | Galvanised mild steel   |
| d) | i) Bolts, nuts & plain washer galvanised<br>ii) Spring washers for items 'a' to 'c' | i) Electro galvanisation for sizes Plain, washers below M12, for others hot dip galvanised.<br>ii) Electro-galvanised mild steel suitable for at least service condition-3 as per IS:1573 |

- 24.2 Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor termination of equipment shall be suitable for Moose ACSR Conductor. The requirement regarding external RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position.
- 24.3 Where copper to aluminium connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of the joint shall be furnished to the Owner by the supplier.
- 24.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of work.
- 24.5 No current carrying part of any of any clamp shall be less than 12 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body for Bi-metallic clamps.
- 24.6 Lateral load deflection test shall be carried out as an acceptance test. The test procedure and accepted norms shall be mutually discussed and agreed to.

- 24.7 All casting shall be free blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 24.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.
- 24.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 24.10 Clamps and connectors shall be designed to be corona controlled. RIV level for 220 kV system shall not be more than 1000/ micro volts respectively at the specified test voltage as per IS/NEMA.

24.11 TESTS

Clamps and connectors shall conform to type tests and shall be subjected to routine tests as per IS:5561.

**25.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT**

- 25.1 All type of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-439, as applicable, and the clauses given below.
- 25.2 Control cabinet, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminium and shall be dust, water and vermin proof. Sheet used shall be least 2.0 mm cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet of specified thickness.
- 25.3 The enclosures of the control cabinets, junction boxes, terminal boxes & marshalling boxes shall provide a degree of protection of not less than IP 55 as per IS: 2147 . The bidder shall offer type tested (IP:55) Marshalling kiosk and type test report for degree of protection test each type of box shall be furnished for arrival. After protection degree test of marshalling kiosk, 2.0 kV r.m.s for 1 (one) minute, insulation resistance and functional test should have been conducted. In case these tests have not been carried out during IP55 test, then the contractor shall carry out the IP-55 test alongwith these tests, at his cost.
- 25.4 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.
- 25.5 All door, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in the presence of Owners representative. The quality of gasket shall be such that it does not get damaged/ cracked during the years of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced of necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass or GI wires.

- 25.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connection. Boxes and cabinet shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall project atleast 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.
- 25.7 A 240V, single phase, 50Hz, 15 amp AC plug and socket shall be provided the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.
- 25.8 For illumination of control cabinet a 7 Watt LED shall be provided.
- 25.9 All control switches shall be of rotary switch type and Toggle/piano switches shall not be provided.

#### 25.10 EARTHING

Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of star of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

#### 25.11 TESTS

The marshalling kiosks shall be subject to routine tests as per 18:5039

The following routine tests shall also be conducted:

Check for wiring

Visual and dimension check

Marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/ferruling by pasting the same on the inside of the door.

### **26.0 AUXILIARY SWITCHES**

The auxiliary switch shall confirm to the following type tests:

Electrical endurance test -A minimum of 2000 operation for 2A DC with a time constant examination of mV drop/visual defects/temperature rise test.

Mechanical endurance test. A minimum of operations as specified in the relevant IS with a subsequent checking of contact pressure test visual examination.

Heat run test on contacts.

### **27.0 TERMINAL BLOCKS AND WIRING**

- 27.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

- 27.2 Terminal blocks shall be 1100 v grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wedge or equivalent. The insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, fluorocarbons etc.
- 27.3 Terminal block for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.
- 27.4 The terminal shall be that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
- 27.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.
- 27.6 The terminal blocks shall be of extensible design.
- 27.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 27.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 27.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

|    |                                  |                                      |
|----|----------------------------------|--------------------------------------|
| a) | All circuits except CT circuits  | Minimum of 2.5 sq.mm copper flexible |
| b) | All CT circuits copper flexible. | Minimum of 4 sq.mm.                  |

- 27.10
  - 27.11 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.
  - 27.12 At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.
  - 27.13 There shall be a minimum clearance of 250 mm between the First bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.
- The Supplier shall furnish all wire, conduits and terminals for the necessary interphase electrical connection (where applicable) as well as between phases and common terminal boxes or control cabinets. The wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltage either transferred through the equipment or due to transients induced from the EHV circuits.
- 27.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability and transverse modes. The supplier shall also provide all necessary to achieve an impulse withstand level at the cable interfaces of equipment.

## **28.0 LAMPS AND SOCKETS**

### **28.1 LAMPS**

All indication lamps shall also be LED based. Socket base shall be as per IS-1258, except in the case of signal lamps.

### **28.2 SOCKETS**

28.3 All sockets (convenience outlets) shall be suitable to accept both 5 A & 15 A pin round Standard Indian plugs. They shall be switched sockets with shutters.

### **28.4 HAND LAMP**

A 240 Volts, single phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

### **28.5 INTERIOR LIGHTING**

Each panel shall be provided with a LED lighting fixture of Standard Indian type rates for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel during maintenance. The Fitting shall be controlled by the respective panel door switch.

### **28.6 SWITCHES AND FUSES**

28.6.1 Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switch fuse units. Selection of the main and Sub-circuit fuse rating shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by fuses.

28.6.2 All fuses be of HRC cartridge type conforming to IS:9228 mounted on plug-in type fuse bases.

28.6.3 Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuses carrier base shall have imprints of the fuse rating and voltage.

## **29.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:**

29.1 The bidder shall offer composite silicon rubber polymer insulator for all insulation purpose as per project requirement, conforming to IEC-61109. In case if non-compliance of composite insulators with respect to State/National electricity authorities guidelines/requirements, the anti-fog type porcelain insulators may be used wherever mandatory. The required deviations with respect to above requirements shall be clearly mentioned in the deviation sheet along with the supporting documents. In absence of such deviations statements, the compliance of this point is mandatory and binding on the vendor.

29.2 Bushing shall be manufactured and tested in accordance with IS:2099 & IEC: 137 while hollow column insulators shall manufactured and tested in accordance with IEC 233/18 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IEC 273. The Insulators shall also conform to IEC 815 as applicable.

29.3 Following requirements to be fulfilled if anti-fog porcelain insulators are provided as instructed in point 29.1 of this chapter.

- 29.3.1 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- 29.3.2 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
- 29.3.3 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical and rigidity for the conditions under which they will be used.
- 29.3.4 When operating at rated voltage there shall be no electric discharge between the conductors and busing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.
- 29.3.5 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and support other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- 29.3.6 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be true up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

#### 29.4 TESTS

Bushing hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS:2099 & IS: 2544.

##### 29.4.1 Technical parameters of bushing/Hollow column insulators/support insulators:

|    |   | 220 kV<br>System  | 132 kV<br>System | 66 kV<br>System | 33 kV<br>System |
|----|---|---|------------------|-----------------|-----------------|
| a) | Rated Voltage (kV)  | 245   | 145              | 72.5            | 36              |
| b) | Impulse withstand voltage (dry and wet) (kVp)   | 1050  | 650              | 325             | 170             |
| c) | Power frequency withstand voltage (dry and wet) (kV) (rms)  | 460   | 275              | 140             | 75              |
| d) | Total creepage distance (mm)  | 25mm/kv   |                  |                 |                 |
| e) | Pollution   | Class – III heavy (as per IEC 71) and as specified in section 2 for all class of equipment. |                  |                 |                 |
| f) | Insulator shall also meet requirement of and IEC-815 as applicable having alternate long and short sheds. |   |                  |                 |                 |

## **30.0 MOTORS**

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and conform to type tests and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

### **30.1 ENCLOSURES**

- a) Motor to be installed shall have enclosure equivalent to IP 55 as per IS:4691.
- b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.
- d) Motor weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate lifting.

## **31.0 RATING PLATES, NAME PLATES AND LABELS**

Each main and auxiliary item of equipment is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment, type or serial number together with details of loading conditions under which the item of equipment in question has been designed to operate and such diagram plates as may be required by the Owner. The rating plate shall conform to IEG requirement.

All such name plates, instruction plates rating plates etc. shall be in bilingual with Hindi inscription first followed by English. Alternatively, two separate plates one with Hindi & the other with English inscription may be provided.

## **32.0 RADIO INTERFERENCE VOLTAGE (RIV) TEST**

### **32.1 GENERAL**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for measurement of radio interference voltage (RIV).

### **32.2 TEST LEVELS**


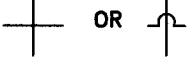
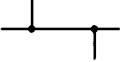
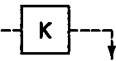
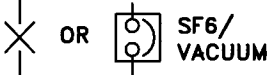






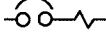

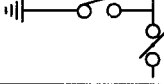


The test voltage levels for measurement of external RIV are listed under the relevant clauses of the specification.

### **32.3 TEST METHOD FOR RIV**

32.3.1 RIV tests shall levels for according to measuring as per International Special- Committee on radio Interference (CISPR) Publication 16-1 (1993) Part-1. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequency being recorded. The results shall be in microvolts.


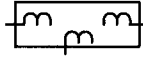



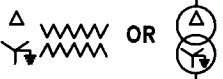









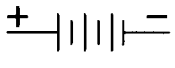
32.3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No.107-1964, except otherwise noted herein.

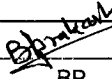

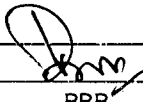

- 32.3.3 In measurement, RIV, temporary additional external shielding may be provided. In measurements of RIV only standard fitting of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.
- 32.3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing voltages 85%, 100%, 115% and
- 32.3.5 130% of the specified RIV test voltage for all equipment unless otherwise specified.
- 32.3.6 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.
- 32.3.7 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.


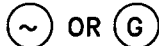














|   |  |
|---|--|
|    | BUS  |
|    | CROSSING OF CONDUCTORS—NOT CONNECTED             |
|    | CONNECTIONS OF CONDUCTORS                        |
|    | KEY INTERLOCK, K—KEY, ARROW TERMINATES AT DEVICE |
|    | SF6 / VACUUM CIRCUIT BREAKER                     |
|    | AIR CIRCUIT BREAKER                              |
|    | DRAWOUT FEATURE                                  |
|  | CABLE GLAND                                      |
|  | AIR BREAK ISOLATOR/DISCONNECT SWITCH             |
|  | OIL IMMERSD ISOLATOR/DISCONNECT SWITCH           |
|  | FUSE   |
|  | AIR CIRCUIT BREAKER WITH INHERENT RELEASES       |
|  | DOUBLE BREAK ISOLATOR                            |
|  | ISOLATOR WITH EARTH SWITCH                       |
|  | LIGHTNING ARRESTOR                               |
|  | CONTACTOR  |

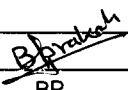
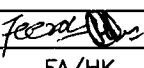


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| 5        | 08.11.16 | UPDATED & ISSUED AS STANDARD | <i>B. Prakash</i><br>BP | <i>Jeeva</i><br>FA/HK | <i>Dom</i><br>BRB        | <i>Am</i><br>RN       |
| 4        | 27.06.11 | REAFFIRMED & ISSUED          | BP                      | RKS/RSC               | UAP                      | DM                    |
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|          |          |                              |                         |                       |                          | Approved by           |

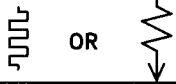














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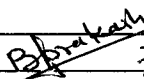
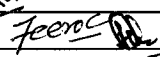
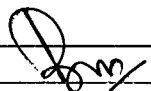

|   |  |
|---|--|
|            | CURRENT TRANSFORMER  |
|            | SUMMATION CT   |
|            | INTERPOSING CT   |
|            | CORE BALANCE CURRENT TRANSFORMER   |
|            | POTENTIAL TRANSFORMER  |
|            | POWER/DISTRIBUTION TRANSFORMER—DESCRIPTION AS NOTED (PRIMARY DELTA CONNECTED, SECONDARY STAR CONNECTED. STAR POINT SOLIDLY EARTHED)                                      |
|           | TRANSFORMER WITH OLTC  |
|          | INSTRUMENT, A- AMMETER, V- VOLTMETER, W- WATTMETER, KWH- KILOWATT HOUR METER, F- FREQUENCY METER, pf- POWER FACTOR METER, HM- HOUR RUN COUNTER MF - MULTI FUNCTION METER |
|  AS / VS | AS- AMMETER SELECTOR SWITCH, VS- VOLTMETER SELECTOR SWITCH   |
|          | FREQUENCY RECORDER   |
|          | VOLTAGE RECORDER   |
|          | TRI VECTOR METER   |
|          | INDICATING LIGHT R- RED, W- WHITE, B- BLUE, Y- YELLOW G- GREEN AND A- AMBER  |
|          | 415V, 3 PHASE POWER/WELDING RECEPTACLE   |
|          | BUS DUCT   |
|          | BATTERY  |

|             |          |                              |   |  |   |   |
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| 5           | 08.11.16 | UPDATED & ISSUED AS STANDARD |  |  |  |  |
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|             |          |                              | BP  | RKS/RSC  | UAP   | DM  |
| Approved by |          |                              |   |  |   |   |

|   |   |
|---|---|
|    | PERMANENT MAGNET GENERATOR  |
|    | GENERATOR—DESCRIPTION AS INDICATED  |
|    | INDUCTION MOTOR   |
|    | SYNCHRONOUS MOTOR   |
|    | MINIATURE CIRCUIT BREAKER (MCB)   |
|    | MINIATURE CIRCUIT BREAKER WITH EARTH LEAKAGE CIRCUIT BREAKER (MCB + ELCB) |
|    | MOULDED CASE CIRCUIT BREAKER (MCCB)                                       |
|  | RECTIFIER   |
|  | INVERTER  |
|  | DC - DC CONVERTER   |
|  | STATIC VOLTAGE REGULATOR  |
|  | AUTOMATIC VOLTAGE REGULATOR   |
|  | PUSH BUTTON STATION / LOCAL CONTROL STATION                               |
|  | PUSH BUTTON STATION WITH AMMETER  |
|  | PUSH BUTTON STATION WITH INDICATING LAMP                                  |
|  | CAPACITOR, VARIABLE CAPACITOR   |


|                               |          |                              |   |  |   |   |
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| 5                             | 08.11.16 | UPDATED & ISSUED AS STANDARD |  |  |  |  |
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
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|---|---|
|    | NEUTRAL GROUNDING RESISTOR  |
|    | NEUTRAL GROUNDING TRANSFORMER   |
|    | TWO WAY SELECTOR SWITCH   |
|    | THREE WAY SELECTOR SWITCH   |
|    | TIME DELAY RELAY  |
|    | DISTANCE PROTECTION RELAY   |
|    | CHECK SYNCHRONISING RELAY   |
|  | 27 - UNDER VOLTAGE RELAY<br>27R - RESIDUAL VOLTAGE CHECK RELAY<br>27M - UNDER VOLTAGE RELAY (MOTOR PROTECTION)<br>27C - VOLTAGE HEALTHY CHECK RELAY |
|  | REVERSE POWER RELAY   |
|  | LOW FORWARD POWER RELAY   |
|  | LOSS OF EXCITATION RELAY  |
|  | NEGATIVE PHASE SEQUENCE RELAY   |
|  | THERMAL OVERLOAD RELAY  |
|  | INSTANTANEOUS OVER CURRENT RELAY  |
|  | INSTANTANEOUS EARTH FAULT RELAY   |

|                               |          |                              |   |  |   |   |  |
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| 5                             | 08.11.16 | UPDATED & ISSUED AS STANDARD |  |  |  |  |  |
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|                       |   |
|-----------------------|---|
| (51)                  | IDMTL OVER CURRENT RELAY                    |
| (51G)                 | STANDBY EARTH FAULT RELAY                   |
| (51N)                 | IDMTL EARTH FAULT RELAY                     |
| (51V)                 | VOLTAGE RESTRAINED IDMTL OVER CURRENT RELAY |
| (59)                  | OVER VOLTAGE RELAY                          |
| (60)                  | NEUTRAL DISPLACEMENT RELAY                  |
| (63TX)                | AUX. RELAY FOR TRANSFORMER TROUBLE/TRIP     |
| (64F)                 | ROTOR EARTH FAULT RELAY                     |
| (64G <sub>1,2</sub> ) | STATOR EARTH FAULT MAIN AND BACKUP RELAY    |
| (64R)                 | RESTRICTED EARTH FAULT RELAY                |
| (67)                  | DIRECTIONAL OVER CURRENT RELAY              |
| (67N)                 | DIRECTIONAL EARTH FAULT RELAY               |
| (78)                  | OUT OF STEP RELAY                           |
| (80)                  | CONTROL SUPPLY SUPERVISION RELAY            |
| (81)                  | UNDER FREQUENCY / df/dt RELAY               |
| (86)                  | LOCKOUT RELAY                               |

|                               |          |                              |             |            |                         |                                     |
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| 5                             | 08.11.16 | UPDATED & ISSUED AS STANDARD | BP          | FA/HK      | BRB                     | RN                                  |
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|   |  |
|---|--|
| (87CH)  | CHECK DIFFERENTIAL RELAY   |
| (87F)   | DIFFERENTIAL RELAY<br>F- FEEDER, G- GENERATOR, T- TRANSFORMER, M- MOTOR,<br>GT- GENERATOR+TRAFORMER COMBINED |
| (95)  | TRIP CIRCUIT SUPERVISION RELAY   |
| (97)  | PT MONITORING RELAY  |
| (98)  | DEAD BUS RELAY   |
| (99)  | OVERFLUXING RELAY  |
| (MPR)   | MOTOR PROTECTION RELAY   |
| (ELR)   | EARTH LEAKAGE RELAY  |
|  | THERMAL OVERLOAD RELAY   |
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
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| SYMBOL | DESCRIPTION  | CODE/AGENCY |
|--------|--|-------------|
|        | A.C. MOTOR   | IEC         |
|        | A.C. GENERATOR                                       | IEC         |
|        | SYNCHRONOUS GENERATOR (GS)                           | IEC         |
|        | SYNCHRONOUS MOTOR (MS)                               | IEC         |
|        | MOTOR STARTER-GENERAL                                | IEC         |
|        | STARTER-NON REVERSING MOTOR                          | IEC         |
|        | STARTER-REVERSING MOTOR                              | IEC         |
|        | STAR-DELTA STARTER                                   | IEC         |
|        | STARTER REGULATOR WITH THYRISTOR                     | IEC         |
|        | DIRECT ON-LINE CONTACTOR STARTER<br>-REVERSING MOTOR | IEC         |
|        | STARTER OPERATING IN STEPS                           | IEC         |
|        | THREE PHASE DELTA-STAR TRANSFORMER                   | IEC         |
|        | THREE PHASE DELTA-STAR TRANSFORMER<br>WITH OLTC      | IEC         |
|        | TRANSFORMER WITH TWO WINDINGS                        | IEC         |
|        | TRANSFORMER WITH THREE WINDINGS                      | IEC         |
|        | VOLTAGE TRANSFORMER                                  | IEC         |


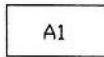











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|          |            |                                 |             |            |                          | Approved by           |

| SYMBOL | DESCRIPTION   | CODE/AGENCY |
|--------|---|-------------|
|        | CURRENT TRANSFORMER   | IEC         |
|        | CURRENT TRANSFORMER, CORE BALANCE   | IEC         |
|        | AUTO TRANSFORMER  | IEC         |
|        | EMERGENCY STOP LOCKING TYPE   | EIL         |
|        | EMERGENCY STOP NON-LOCKING TYPE   | EIL         |
|        | THREE PHASE WINDING, STAR   | IEC         |
|        | THREE PHASE WINDING, DELTA  | IEC         |
|        | THREE PHASE WINDING, STAR WITH NEUTRAL BROUGHT OUT  | IEC         |
|        | CIRCUIT BREAKER, GENERAL  | IEC         |
|        | CIRCUIT BREAKER, 1 POLE   | IEC         |
|        | CIRCUIT BREAKER, 3 POLE * =DENOTES TYPE<br>ACB = AIR CIRCUIT BREAKER<br>VCB = VACUUM CIRCUIT BREAKER<br>MCCB = MOULDED CASE CKT. BREAKER<br>MCB = MINIATURE CIRCUIT BREAKER<br>SF6 = SULPHUR HEXAFLUORIDE CIRCUIT BREAKER | IEC         |
|        | DISCONNECTOR (ISOLATOR) 3 POLE  | EIL         |
|        | SWITCH DISCONNECTOR, 3 POLE (ON-LOAD ISOLATING SWITCH)  | EIL         |
|        | SWITCH DISCONNECTOR, 3 POLE NEUTRAL (ON-LOAD ISOLATING SWITCH)  | EIL         |
|        | SWITCH DISCONNECTOR, 3 POLE NEUTRAL(FIXED) ON-LOAD ISOLATING SWITCH   | EIL         |

|          |            |                                 |             |            |                          |                       |
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| SYMBOL  | DESCRIPTION  | CODE/AGENCY |
|---|--|-------------|
|    | FUSE, GENERAL  | IEC         |
|    | MULTIPLE FUSE  | EIL         |
|    | FUSE SHOWING POWER FLOW DIRECTION  | IEC         |
|    | FUSE SWITCH 3 POLE   | EIL         |
|    | CONTACTOR  | IEC         |
|    | ARROWHEAD  | EIL         |
|   | CONNECTION POINT   | IEC         |
|  | TERMINAL   | IEC         |
|  | CABLE TERMINATION  | IEC         |
|  | PLUG AND SOCKET  | IEC         |
|  | KEY INTERLOCK  | IEC         |
|  | MECHANICAL INTERLOCK   | EIL         |
|  | ELECTRICAL INTERLOCK   | EIL         |
|  | REMOVABLE LINK   | IEC         |
|  | <b>INTEGRATING METER</b><br>A1 = DENOTES TYPE<br>Wh = WATT HOUR METER<br>h = HOURS RUN METER<br>Ah = AMPERE-HOUR METER | IEC         |

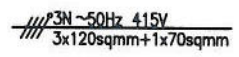





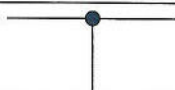


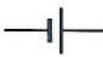




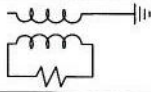
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| SYMBOL  | DESCRIPTION  | CODE/AGENCY |
|---|--|-------------|
|    | <b>INDICATING INSTRUMENT</b><br>A1 = DENOTES TYPE<br>V = VOLTMETER<br>A = AMMETER<br>Hz = FREQUENCY METER<br>$\cos \phi$ = POWER FACTOR METER<br>Var = VAR METER<br>Hz = FREQUENCY METER<br>$\phi$ = PHASE METER<br>n = TACHOMETER | IEC         |
|    | <b>RECORDING INSTRUMENT</b><br>A1 = DENOTES TYPE<br>W = WATT METER   | IEC         |
|    | SYNCHROSCOPE   | IEC         |
|   | 1 PHASE/NEUTRAL/EARTH  | EIL         |
|  | 3 PHASE  | EIL         |
|  | 3 PHASE/NEUTRAL/EARTH  | EIL         |
|  | DRAWOUT FEATURE  | EIL         |
|  | BUSDUCT  | EIL         |
|  | CENTRE BREAK DISCONNECT  | EIL         |
|  | INTEGRAL EARTHING SWITCHGEAR   | EIL         |
|  | ROTATING DISCONNECT CLOCKWISE EARTHING SWITCH  | EIL         |
|  | AMMETER SELECTOR SWITCH  | EIL         |
|  | VOLTMETER SELECTOR SWITCH  | EIL         |

|             |            |                                 |             |            |                         |                      |
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| SYMBOL | DESCRIPTION  | CODE/AGENCY |
|--------|--|-------------|
|        | OVERCURRENT PROTECTION   | EIL         |
|        | THERMAL OVERCURRENT PROTECTION   | EIL         |
|        | MAGNETIC OVERCURRENT PROTECTION  | EIL         |
|        | UNDER VOLTAGE PROTECTION   | EIL         |
|        | EARTH LEAKAGE PROTECTION BY CURRENT                                      | EIL         |
|        | EARTH LEAKAGE PROTECTION BY VOLTAGE                                      | EIL         |
|        | LOCKING DEVICE PADLOCK FACILITY  | EIL         |
|        | MECHANICAL INTERLOCK BETWEEN TWO DEVICES                                 | EIL         |
|        | AUTOMATIC RETURN   | EIL         |
|        | OPERATED BY KEY  | IEC         |
|        | OPERATED BY ELECTRIC MOTOR   | IEC         |
|        | MOTOR-OPERATED VALVE   | EIL         |
|        | REMOTE CONTROL UNIT WITH AMMETER<br>CONTROLLED BY ROTARY STACK SWITCH    | EIL         |
|        | REMOTE CONTROL UNIT WITHOUT AMMETER<br>CONTROLLED BY ROTARY STACK SWITCH | EIL         |
|        | REMOTE CONTROL UNIT WITH AMMETER<br>CONTROLLED BY PUSH BUTTON            | EIL         |
|        | REMOTE CONTROL UNIT WITHOUT<br>AMMETER CONTROLLED BY PUSH BUTTON         | EIL         |

|             |            |                                 |             |            |                          |                       |
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| SYMBOL  | DESCRIPTION                                       | CODE/AGENCY |
|---|---|-------------|
|    | CABLE SINGLE LINE REPRESENTATION                  | EIL         |
|    | EQUIPOTENTIALITY                                  | EIL         |
|    | BUSBAR  | EIL         |
|    | PROTECTIVE EARTH                                  | IEC         |
|    | CHANGE-OVER CONTACT WITH<br>CENTRE-OFF POSITION   | IEC         |
|    | STATIC SWITCH PASSING CURRENT<br>IN ONE DIRECTION | EIL         |
|  | T CONNECTION                                      | IEC         |
|  | LIGHTENING ARRESTOR                               | IEC         |
|  | REACTOR   | IEC         |
|  | BATTERY (PRIMARY OR SECONDARY CELLS)              | IEC         |
|  | RECTIFIER   | IEC         |
|  | INVERTER  | IEC         |
|  | DC/DC CONVERTOR                                   | IEC         |
|  | NEUTRAL GROUNDING RESISTOR                        | EIL         |
|  | NEUTRAL GROUNDING TRANSFORMER                     | EIL         |

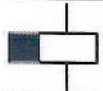
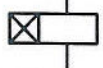
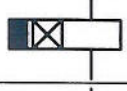
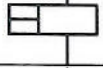

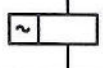










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| SYMBOL | DESCRIPTION   | CODE/AGENCY |
|--------|---|-------------|
|        | START PUSH-BUTTON AND AUTOMATIC RETURN  | IEC         |
|        | STOP PUSH-BUTTON  | EIL         |
|        | MAKE CONTACT DELAYED WHEN CLOSING   | IEC         |
|        | MAKE CONTACT DELAYED WHEN OPENING   | IEC         |
|        | BREAK CONTACT DELAYED WHEN OPENING  | IEC         |
|        | BREAK CONTACT DELAYED WHEN CLOSING  | IEC         |
|        | MAKE CONTACT  | IEC         |
|        | BREAK CONTACT   | IEC         |
|        | CHANGE-OVER CONTACT BREAK BEFORE MAKE   | IEC         |
|        | CHANGE-OVER CONTACT MAKE BEFORE BREAK   | IEC         |
|        | CONTACT WITH TWO MAKES  | IEC         |
|        | CONTACT WITH TWO BREAKS   | IEC         |
|        | INDICATING LAMP<br>* = DENOTES COLOUR<br>GN = GREEN YE = YELLOW<br>RD = RED BU = BLUE<br>WH = WHITE | IEC         |
|        | FUSE SWITCH   | IEC         |
|        | CIRCUIT BREAKER WITH AUTOMATIC RELEASE  | EIL         |
|        | RELAY CONTACT MAKE WITH SPRING RETURN   | EIL         |

|                               |            |                                 |             |            |                          |                                     |
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| SYMBOL | DESCRIPTION  | CODE/AGENCY |
|--------|--|-------------|
|        | DISCONNECTOR (ISOLATOR)                                    | IEC         |
|        | SWITCH-DISCONNECTOR<br>(ON-LOAD ISOLATING SWITCH)          | IEC         |
|        | FUSE DISCONNECTOR (FUSE ISOLATOR)                          | IEC         |
|        | FUSE SWITCH DISCONNECTOR<br>(ONLOAD ISOLATING FUSE SWITCH) | IEC         |
|        | ANTI-CONDENSATION HEATER                                   | IEC         |
|        | CONTACTOR COIL   | EIL         |
|        | EARTH (GROUND), GENERAL SYMBOL                             | IEC         |
|        | CHASSIS OR FRAME EARTH                                     | IEC         |
|        | CLEAN EARTH (NOISELESS)                                    | IEC         |
|        | THERMAL O/L RELAY-OPERATING DEVICE                         | IEC         |
|        | DIODE  | IEC         |
|        | THYRISTOR  | IEC         |
|        | TERMINAL STRIP   | IEC         |
|        | RESISTOR, GENERAL  | IEC         |
|        | ADJUSTABLE RESISTOR  | IEC         |
|        | RELAY COIL OF PERMANENT RELAY                              | IEC         |

|          |            |                                 |             |            |                          |                       |
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| SYMBOL  | DESCRIPTION   | CODE/AGENCY |
|---|---|-------------|
|    | RELAY COIL OF SLOW RELEASING RELAY  | IEC         |
|    | RELAY COIL OF SLOW OPERATING RELAY  | IEC         |
|    | RELAY COIL- SLOW OPERATING<br>SLOW RELEASING RELAY                                  | IEC         |
|    | RELAY COIL- HIGH SPEED RELAY<br>(FAST OPERATING & RELEASING)                        | IEC         |
|    | RELAY COIL- POLARISED RELAY   | IEC         |
|    | RELAY COIL OF ALTERNATING CURRENT RELAY   | IEC         |
|   | CAPACITOR, GENERAL  | IEC         |
|  | POLARISED CAPACITOR   | IEC         |
|  | ADJUSTABLE CAPACITOR  | IEC         |
|  | INDUCTOR, COIL, WINDING CHOKE   | IEC         |
|  | PHOTOVOLTIC CELL  | IEC         |
|  | PHOTO DIODE (PHOTO CONDUCTIVE<br>WITH ASYMMETRICAL CONDUCTIVITY)                    | IEC         |
|  | LIGHT DEPENDENT RESISTOR (PHOTO CONDUCTIVE<br>DEVICE WITH SYMMETRICAL CONDUCTIVITY) | IEC         |
|  | 2 POSITION SWITCH   | IEC         |
|  | 3 POSITION SWITCH   | IEC         |
|  | 4 POSITION SWITCH   | IEC         |

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| SYMBOL | DESCRIPTION  | CODE/AGENCY |
|--------|--|-------------|
| R1     | RELAY COIL GENERAL   | IEEE/NEMA   |
| AVR    | AUTOMATIC VOLTAGE REGULATOR RELAY  | EIL         |
| U=0    | NO VOLTAGE RELAY   | IEC         |
| 2      | TIME DELAY RELAY   | IEEE/NEMA   |
| 12     | OVERSPEED RELAY  | IEEE/NEMA   |
| 21     | DISTANCE PROTECTION RELAY  | IEEE/NEMA   |
| 25     | CHECK SYNCHRONISING RELAY  | IEEE/NEMA   |
| 27     | 27 – UNDER VOLTAGE RELAY<br>27R – RESIDUAL VOLTAGE CHECK RELAY<br>27M – UNDER VOLTAGE RELAY<br>(MOTOR PROTECTION)<br>27H – VOLTAGE HEALTHY CHECK RELAY | IEEE/NEMA   |
| 32     | REVERSE POWER / DIRECTIONAL POWER RELAY  | IEEE/NEMA   |
| 37     | LOW FORWARD POWER / UNDER CURRENT RELAY  | IEEE/NEMA   |
| 40     | LOSS OF EXCITATION RELAY   | IEEE/NEMA   |
| 46     | NEGATIVE PHASE SEQUENCE RELAY  | IEEE/NEMA   |
| 49     | THERMAL OVERLOAD RELAY   | IEEE/NEMA   |
| 50     | INSTANTANEOUS OVER CURRENT RELAY   | IEEE/NEMA   |
| 50N    | INSTANTANEOUS EARTH FAULT RELAY  | IEEE/NEMA   |

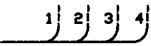
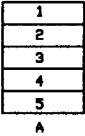
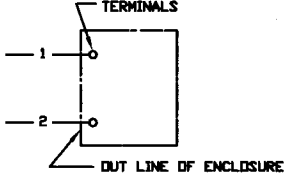











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| SYMBOL  | DESCRIPTION                                    | CODE/AGENCY |
|---------|--|-------------|
| 51      | IDMTL OVER CURRENT RELAY                       | IEEE/NEMA   |
| 51G     | STANDBY EARTH FAULT RELAY                      | IEEE/NEMA   |
| 51N     | IDMTL EARTH FAULT RELAY                        | IEEE/NEMA   |
| 51V     | VOLTAGE RESTRAINED IDMTL<br>OVER CURRENT RELAY | IEEE/NEMA   |
| 59      | OVER VOLTAGE RELAY                             | IEEE/NEMA   |
| 60      | NEUTRAL DISPLACEMENT RELAY                     | IEEE/NEMA   |
| 63TX    | AUX. RELAY FOR TRANSFORMER<br>TROUBLE/TRIP     | IEEE/NEMA   |
| 64F     | ROTOR EARTH FAULT RELAY                        | IEEE/NEMA   |
| 64G 1,2 | STATOR EARTH FAULT MAIN<br>AND BACKUP RELAY    | IEEE/NEMA   |
| 64R     | RESTRICTED EARTH FAULT RELAY                   | IEEE/NEMA   |
| 67      | DIRECTIONAL OVER CURRENT RELAY                 | IEEE/NEMA   |
| 67N     | DIRECTIONAL EARTH FAULT RELAY                  | IEEE/NEMA   |
| 78      | OUT OF STEP RELAY                              | IEEE/NEMA   |
| 80      | CONTROL SUPPLY SUPERVISION RELAY               | IEEE/NEMA   |
| 81      | UNDER FREQUENCY / $df/dt$ RELAY                | IEEE/NEMA   |
| 86      | LOCKOUT RELAY                                  | IEEE/NEMA   |

|          |            |                                 |             |            |                          |                       |
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| SYMBOL | DESCRIPTION   | CODE/AGENCY |
|--------|---|-------------|
| 87CH   | CHECK DIFFERENTIAL RELAY  | IEEE/NEMA   |
| 87F    | DIFFERENTIAL RELAY<br>F-FEEDER, G-GENERATOR,<br>T-TRANSFORMER, GT-GEN.+TRAFO. | IEEE/NEMA   |
| 95     | TRIP CIRCUIT SUPERVISION RELAY  | IEEE/NEMA   |
| 97     | PT MONITORING RELAY   | IEEE/NEMA   |
| 98     | DEAD BUS RELAY  | IEEE/NEMA   |
| 99     | OVERFLUXING RELAY   | IEEE/NEMA   |
| MPR    | MOTOR PROTECTION RELAY  | EIL         |
| ELR    | EARTH LEAKAGE RELAY   | EIL         |
|        |   |             |
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|   |   |                                |
|---|---|--------------------------------|
|    | GROUPING OF CONDUCTORS, LINE BEND INDICATES DIRECTION OF CONDUCTOR JOINING CABLE, NUMERAL INDICATES WIRE NUMBER |                                |
|    | TERMINAL BLOCK 'A', NUMERAL INDICATES TERMINAL NUMBER   |                                |
|    | WIRES DESIGNATED 1 & 2 ARE CONNECTED TO TERMINALS OF AN APPARATUS   |                                |
|    | HOOTER<br>H - HORN<br>S - SIREN<br>LSP - LOUDSPEAKER  |                                |
|   | RELAY COIL, 2 - INDICATES RELAY NUMBER  |                                |
|  | BREAK CONTACT<br>DELAYED BREAK  |                                |
|  | MAKE CONTACT<br>DELAYED MAKE  |                                |
|  | BREAK CONTACT<br>DELAYED MAKE   |                                |
|  | MAKE CONTACT<br>DELAYED BREAK   |                                |
|  | OPEN CONTACT - THE POSITION OF THE CONTACT IN A RELAY IS SHOWN WITH COIL DE-ENERGISED                           |                                |
|  | CLOSED CONTACT - THE POSITION OF THE CONTACT IN A RELAY IS SHOWN WITH COIL DE-ENERGISED                         |                                |
|  | MOTOR, 3 PHASE  |                                |
|  | NORMALLY OPEN   | TEMPERATURE<br>ACTUATED SWITCH |
|  | NORMALLY CLOSED   |                                |

|                               |          |                              |             |              |                          |                                     |
|-------------------------------|----------|------------------------------|-------------|--------------|--------------------------|-------------------------------------|
| 5                             | 08.11.16 | UPDATED & ISSUED AS STANDARD | <i>BP</i>   | <i>FA/HK</i> | <i>BRB</i>               | <i>RN</i>                           |
| 4                             | 27.06.11 | REAFFIRMED & ISSUED          | BP          | RKS/RSC      | UAP                      | DM                                  |
| Rev. No.                      | Date     | Purpose                      | Prepared by | Checked by   | Stds. Committee Convener | Stds. Bureau Chairman               |
|                               |          |                              |             |              |                          | Approved by                         |
| Format No. 8-00-0001-F4 Rev.0 |          |                              |             |              |                          | Copyright EIL - All rights reserved |

|  |  |                         |
|--|--|-------------------------|
|  | HELD CLOSE   | LIMIT SWITCH            |
|  | HELD OPEN  |                         |
|  | NORMALLY OPEN<br>(OPEN ON LOW PRESSURE)                                      | VACUUM/ PRESSURE SWITCH |
|  | NORMALLY CLOSE<br>(CLOSED ON LOW PRESSURE)                                   |                         |
|  | PUSH BUTTON - CLOSING, SINGLE CIRCUIT, MOMENTARY OR SPRING RETURN            |                         |
|  | PUSH BUTTON - OPENING, SINGLE CIRCUIT, MOMENTARY OR SPRING RETURN            |                         |
|  | PUSH BUTTON, TWO CIRCUIT, MOMENTARY OR SPRING RETURN                         |                         |
|  | PUSH BUTTON, TWO CIRCUIT, MAINTAINED OR NON-SPRING RETURN                    |                         |
|  | SEMICONDUCTOR DIODE  |                         |
|  | SILICON CONTROL RECTIFIER  |                         |
|  | FULL WAVE RECTIFIER  |                         |
|  | FUSE   |                         |
|  | EMG. STOP  |                         |
|  | STAY PUT EMERGENCY STOP (MUSHROOM HEAD)<br>PUSH BUTTON WITH RESETING FEATURE |                         |
|  | EARTH CONNECTION   |                         |

|          |          |                              |             |              |                          |                       |
|----------|----------|------------------------------|-------------|--------------|--------------------------|-----------------------|
| 5        | 08.11.16 | UPDATED & ISSUED AS STANDARD | <i>BP</i>   | <i>FA/HK</i> | <i>BRB</i>               | <i>RN</i>             |
| 4        | 27.06.11 | REAFFIRMED & ISSUED          | BP          | RKS/RSC      | UAP                      | DM                    |
| Rev. No. | Date     | Purpose                      | Prepared by | Checked by   | Stds. Committee Convener | Stds. Bureau Chairman |
|          |          |                              |             |              |                          | Approved by           |

| Sr No                     | Supplier Code | Supplier Name   | Country | Holiday Description |
|---------------------------|---------------|---|---------|---------------------|
| <b>Item Code : 130D</b>   |               | <b>Description : CABLES:CONTROL (UNPAIRED)-PVC/XLPE</b> |         |                     |
| <b>Approved Suppliers</b> |               |   |         |                     |
| 1                         | 3854          | CHANDRESH CABLES LIMITED                                | INDIA   |                     |
| 2                         | 3872          | GUPTA POWER INFRASTRUCTURE LIMITED                      | INDIA   |                     |
| 3                         | K190A         | KEC INTERNATIONAL LIMITED                               | INDIA   |                     |
| 4                         | 3752          | APAR INDUSTRIES LTD                                     | INDIA   |                     |
| 5                         | T212          | THERMO CABLES LTD (FORM. T-150)                         | INDIA   |                     |
| 6                         | S304          | SUYOG ELECTRICALS LTD                                   | INDIA   |                     |
| 7                         | 3602          | Special Cables Pvt. Ltd.                                | INDIA   |                     |
| 8                         | S025          | SRIRAM CABLES PVT LTD                                   | INDIA   |                     |
| 9                         | A034          | ASSOCIATED CABLES PVT LTD                               | INDIA   |                     |
| 10                        | U003          | UNIVERSAL CABLES LTD                                    | INDIA   |                     |
| 11                        | 3722          | POLYCAB INDIA LIMITED                                   | INDIA   |                     |
| 12                        | G156          | GEMSCAB INDUSTRIES LTD                                  | INDIA   |                     |
| 13                        | 3724          | CORDS CABLE INDUSTRIESLTD.                              | INDIA   |                     |
| 14                        | C145          | CORDS CABLE INDUSTRIES LTD                              | INDIA   |                     |
| 15                        | K082          | KEI INDUSTRIES LIMITED                                  | INDIA   |                     |
| 16                        | E063          | ELKAY TELELINKS LTD.-                                   | INDIA   |                     |
| 17                        | 3783          | POLYCAB INDIA LIMITED                                   | INDIA   |                     |
| 18                        | T124          | TCL CABLES PRIVATE LIMITED                              | INDIA   |                     |
| 19                        | A132          | ASSOCIATED FLEXIBLES & WIRES [P] LTD                    | INDIA   |                     |
| 20                        | 3669          | KEI INDUSTRIES LIMITED                                  | INDIA   |                     |
| 21                        | 3765          | THERMO CABLES LTD.                                      | INDIA   |                     |
| 22                        | 3784          | POLYCAB INDIA LIMITED                                   | INDIA   |                     |
| 23                        | D012          | DELTON CABLES LIMITED                                   | INDIA   |                     |
| 24                        | H060          | HAVELLS INDIA LTD                                       | INDIA   |                     |
| 25                        | 3814          | RR KABEL LIMITED  | INDIA   |                     |
| <b>On Holiday</b>         |               |   |         |                     |
| 1                         | R203          | RALLISON ELECTRICALS PVT. LTD.                          | INDIA   |                     |
| 2                         | N112          | NORTH EASTERN CABLES PVT LTD                            | INDIA   |                     |
| 3                         | R203          | RALLISON ELECTRICALS PVT. LTD.                          | INDIA   |                     |
| 4                         | S073          | SCOT INNOVATION WIRES & CABLES PVT LTD                  | INDIA   |                     |
| 5                         | I211          | ICON CABLE LTD.   | INDIA   |                     |
| 6                         | F013          | FINOLEX CABLES LTD.                                     | INDIA   |                     |
| 7                         | C019          | CMI LIMITED   | INDIA   |                     |
| 8                         | R203          | RALLISON ELECTRICALS PVT. LTD.                          | INDIA   |                     |
| 9                         | E169          | ECKO CABLES PVT LTD                                     | INDIA   |                     |

| Sr No                   | Supplier Code | Supplier Name   | Country | Holiday Description |
|-------------------------|---------------|---|---------|---------------------|
| <b>Item Code : 13OD</b> |               | <b>Description : CABLES:CONTROL (UNPAIRED)-PVC/XLPE</b> |         |                     |
| 10                      | R179          | RAVIN CABLES LTD  | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                            | Country | Holiday Description |
|---------------------------|---------------|--|---------|---------------------|
| <b>Item Code : 14CD</b>   |               | <b>Description : CONTACTORS</b>          |         |                     |
| <b>Approved Suppliers</b> |               |  |         |                     |
| 1                         | A200          | ABB INDIA LTD (BANGALORE)                | INDIA   |                     |
| 2                         | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD | INDIA   |                     |
| 3                         | G147          | GE INDIA INDUSTRIAL PVT LTD              | INDIA   |                     |
| 4                         | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 5                         | B002          | BCH ELECTRIC LTD                         | INDIA   |                     |
| 6                         | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED | INDIA   |                     |
| <b>On Holiday</b>         |               |  |         |                     |
| 1                         | 3791          | C & S ELECTRIC LTD                       | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                                   | Country | Holiday Description |
|---------------------------|---------------|---|---------|---------------------|
| <b>Item Code : 14CE</b>   |               | <b>Description : CONTROL SWITCHES (BREAKER)</b> |         |                     |
| <b>Approved Suppliers</b> |               |   |         |                     |
| 1                         | R159          | RELIABLE ELECTRONIC COMPONENTS PVT LTD          | INDIA   |                     |
| 2                         | S373          | SWITRON DEVICES                                 | INDIA   |                     |
| 3                         | A392          | GE T&D INDIA LIMITED                            | INDIA   |                     |



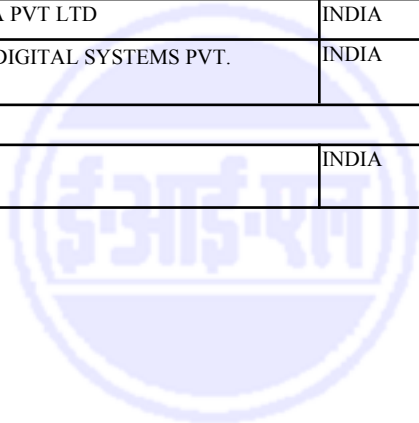
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| Sr No                     | Supplier Code | Supplier Name   | Country | Holiday Description |
|---------------------------|---------------|---|---------|---------------------|
| <b>Item Code : 14CF</b>   |               | <b>Description : CONTROL SWITCHES / SELECTOR SWITCHES</b> |         |                     |
| <b>Approved Suppliers</b> |               |   |         |                     |
| 1                         | A392          | GE T&D INDIA LIMITED                                      | INDIA   |                     |
| 2                         | S373          | SWITRON DEVICES   | INDIA   |                     |
| 3                         | K143          | KAYCEE INDUSTRIES LTD.                                    | INDIA   |                     |
| 4                         | S003          | SIEMENS LIMITED   | INDIA   |                     |
| 5                         | R159          | RELIABLE ELECTRONIC COMPONENTS PVT LTD                    | INDIA   |                     |
| 6                         | H142          | HOTLINE SWITCHGEAR & CONTROLS                             | INDIA   |                     |
| 7                         | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED                  | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                                   | Country | Holiday Description |
|---------------------------|---------------|---|---------|---------------------|
| <b>Item Code : 14MA</b>   |               | <b>Description : MCB</b>                        |         |                     |
| <b>Approved Suppliers</b> |               |   |         |                     |
| 1                         | 3824          | HAVELLS INDIA LIMITED                           | INDIA   |                     |
| 2                         | S003          | SIEMENS LIMITED                                 | INDIA   |                     |
| 3                         | A372          | ABB INDIA LTD                                   | INDIA   |                     |
| 4                         | L071          | LEGRAND (INDIA) PVT. LTD (FORM. M-006)          | INDIA   |                     |
| 5                         | I168          | INDIANA CURRENT CONTROL LTD                     | INDIA   |                     |
| 6                         | 3888          | POLYCAB INDIA LIMITED                           | INDIA   |                     |
| 7                         | S393          | STANDARD ELECTRICALS LTD                        | INDIA   |                     |
| 8                         | S450          | SCHNEIDER ELECTRIC INDIA PVT LTD                | INDIA   |                     |
| 9                         | 3726          | NOVATEUR ELECTRICAL & DIGITAL SYSTEMS PVT. LTD. | INDIA   |                     |
| <b>On Holiday</b>         |               |   |         |                     |
| 1                         | 3793          | C & S ELECTRIC LTD                              | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                            | Country | Holiday Description |
|---------------------------|---------------|--|---------|---------------------|
| <b>Item Code : 14MB</b>   |               | <b>Description : MCCB</b>                |         |                     |
| <b>Approved Suppliers</b> |               |  |         |                     |
| 1                         | A200B         | ABB INDIA LTD                            | INDIA   |                     |
| 2                         | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 3                         | G147          | GE INDIA INDUSTRIAL PVT LTD              | INDIA   |                     |
| 4                         | L001C         | LARSEN & TOUBRO LTD-POWAI                | INDIA   |                     |
| 5                         | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                            | Country       | Holiday Description |
|---------------------------|---------------|--|---------------|---------------------|
| <b>Item Code : 14PA</b>   |               | <b>Description : PROTECTION RELAYS</b>   |               |                     |
| <b>Approved Suppliers</b> |               |  |               |                     |
| 1                         | A070          | ABB INDIA LTD (BARODA)                   | INDIA         |                     |
| 2                         | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD | INDIA         |                     |
| 3                         | S003B         | SIEMENS LTD - GOA                        | INDIA         |                     |
| 4                         | E143          | EASUN REYROLLE LTD                       | INDIA         |                     |
| 5                         | A392          | GE T&D INDIA LIMITED                     | INDIA         |                     |
| 6                         | S824          | SCHWEITZER ENGINEERING LABORATORIES      | UNITED STATES |                     |



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| Sr No  | Supplier Code | Supplier Name                            | Country | Holiday Description |
|--|---------------|--|---------|---------------------|
| <b>Item Code : 14PB Description : PUSH BUTTON AND INDICATING LAMPS</b> |               |  |         |                     |
| <b>Approved Suppliers</b>  |               |  |         |                     |
| 1  | L001C         | LARSEN & TOUBRO LTD-POWAI                | INDIA   |                     |
| 2  | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD | INDIA   |                     |
| 3  | B002          | BCH ELECTRIC LTD                         | INDIA   |                     |
| 4  | S365          | SHRI TULSI SWITCHGEARS PVT LTD           | INDIA   |                     |
| 5  | H142          | HOTLINE SWITCHGEAR & CONTROLS            | INDIA   |                     |
| 6  | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 7  | P291          | PRECIFINE PRODUCTS PVT. LTD.             | INDIA   |                     |
| 8  | E173          | ESSEN DEINKI                             | INDIA   |                     |
| 9  | T166          | TEKNIC ELECTRIC (I) PVT. LTD.            | INDIA   |                     |
| <b>On Holiday</b>  |               |  |         |                     |
| 1  | 3791          | C & S ELECTRIC LTD                       | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                                | Country | Holiday Description |
|---------------------------|---------------|--|---------|---------------------|
| <b>Item Code : 14SA</b>   |               | <b>Description : FUSE SWITCH COMBINATION</b> |         |                     |
| <b>Approved Suppliers</b> |               |  |         |                     |
| 1                         | I013          | NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P      | INDIA   |                     |
| 2                         | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED     | INDIA   |                     |
| 3                         | S393          | STANDARD ELECTRICALS LTD                     | INDIA   |                     |
| 4                         | S003          | SIEMENS LIMITED                              | INDIA   |                     |
| 5                         | G147          | GE INDIA INDUSTRIAL PVT LTD                  | INDIA   |                     |
| 6                         | 3825          | HAVELLS INDIA LIMITED                        | INDIA   |                     |
| <b>On Holiday</b>         |               |  |         |                     |
| 1                         | 3790          | C & S ELECTRIC LTD                           | INDIA   |                     |



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| Sr No                     | Supplier Code | Supplier Name                            | Country | Holiday Description |
|---------------------------|---------------|--|---------|---------------------|
| <b>Item Code : 14TA</b>   |               | <b>Description : TIMERS</b>              |         |                     |
| <b>Approved Suppliers</b> |               |  |         |                     |
| 1                         | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 2                         | E151          | ELECTRONIC AUTOMATION PVT LTD            | INDIA   |                     |
| 3                         | B002          | BCH ELECTRIC LTD                         | INDIA   |                     |
| 4                         | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED | INDIA   |                     |



066053057049

## VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✓" shall be furnished by the bidder.

### GIS PACKAGES

| S.<br>N.<br>O. | DESCRIPTION  | WITH<br>BID | POST ORDER    |               |                                 | REMARKS |
|----------------|--|-------------|---------------|---------------|---------------------------------|---------|
|                |  |             | FOR<br>REVIEW | FOR<br>RECORD | WITH<br>DATA<br>BOOK<br>(FINAL) |         |
| 1.             | Filled in Technical Compliance Checklist attached with tender  | ✓           |               |               |                                 |         |
| 2.             |  | ✓           | ✓             |               | ✓                               |         |
| 3.             |  |             | ✓             |               | ✓                               |         |
| 4.             | Electrical interface Document (Battery Limit Interface) with Owner   |             | ✓             |               | ✓                               |         |
| 5.             | System Study Report: Electrical Load Data, Load Analysis, Load Flow, Short Circuit calculation                                       |             | ✓             |               | ✓                               |         |
| 6.             |  |             |               |               |                                 |         |
| 7.             |  |             |               |               |                                 |         |
| 8.             |  |             |               |               |                                 |         |
| 9.             | Study Reports: Insulation Co-ordination Study report, Relay Co-ordination Study Report   |             | ✓             |               | ✓                               |         |
| 10.            | 3 D Model Review Report  |             |               | ✓             | ✓                               |         |
| 11.            | Miscellaneous Schedules: Equipment List/ Motor List/ Lighting Panel/ Power Panel/ LCS Schedule, etc.                                 |             |               | ✓             | ✓                               |         |
| 12.            | Cable Schedule, Interconnection Document   |             |               | ✓             | ✓                               |         |
| 13.            | ECS & DCS Interface Document and Interconnection Drawing   |             |               | ✓             | ✓                               |         |
| 14.            |  |             |               |               |                                 |         |
| 15.            | Test Records, Type Test Certificates for Miscellaneous Equipments  |             |               | ✓             | ✓                               |         |
| 16.            | List of Mandatory Spares   |             | ✓             |               | ✓                               |         |
| 17.            | List of Maintenance Spares, Commissioning Spares, Special Tools and Tackles  |             |               |               | ✓                               |         |
| 18.            | Data Books/ Manuals : Installation Manual, Operating/ Maintenance Manual, Catalogues/ Brochures, Equipment storage procedure at site |             |               |               | ✓                               |         |
| 19.            |  |             |               |               |                                 |         |

| S. N O. | DESCRIPTION | WITH BID | POST ORDER |            |                        | REMARKS |
|---------|-------------|----------|------------|------------|------------------------|---------|
|         |             |          | FOR REVIEW | FOR RECORD | WITH DATA BOOK (FINAL) |         |
| 20.     |             |          |            |            |                        |         |

## EHV- GIS

| S. N O. | DESCRIPTION  | WITH BID | POST ORDER |            |                        | REMARKS               |
|---------|--|----------|------------|------------|------------------------|-----------------------|
|         |  |          | FOR REVIEW | FOR RECORD | WITH DATA BOOK (FINAL) |                       |
| 1.      | Data Sheets (Duly filled-in), GA Drawings (Elevation and Plan) of GIS, LCC including clearance requirements  | ✓        | ✓          |            | ✓                      |                       |
| 2.      | Installation Plan including foundation, cutout and mounting details of GIS, LCC, Cross Sectional View, Name Plate Drawing, Gas SLD, Gas filling arrangement details  |          |            | ✓          | ✓                      |                       |
| 3.      | Single Line Diagram, Arrangement of cable termination, CT/PT burdens, Vk, Im, RCT etc. for class PS CT's, surge arrester, List of Mandatory Spares   |          | ✓          |            | ✓                      |                       |
| 4.      | Control Schematics, Wiring Diagram and Terminal Details, Interpanel Wiring Diagram, Bill Of Material, Auxiliary Power Data (AC & DC), Interlock Details, ECS I/O List  |          |            | ✓          | ✓                      |                       |
| 5.      | Substation Automation System Drawings: GA Drawing of Panel, System Architecture  |          | ✓          |            | ✓                      |                       |
| 6.      | Substation Automation System Drawings: Power Requirement, Bill of Material   |          |            | ✓          | ✓                      |                       |
| 7.      | Drawing/ Details of SF6 Gas leakage detector, Gas filling and evacuation plant, SF6 Gas analyser, Portable Partial Discharge monitoring system, Online SF6 gas topping system  |          |            | ✓          | ✓                      |                       |
| 8.      | Inspection & Test Plan (ITP) -For review by Inspection Dept.   |          | ✓          |            | ✓                      | <i>Refer Note-1**</i> |
| 9.      | Type Test Certificate (For identical design of GIS)  |          |            | ✓          | ✓                      |                       |
| 10.     | Test Records   |          |            | ✓          | ✓                      |                       |
| 11.     | Calculation of critical field strength, Calculation in support of average intensity of electromagnetic field on surface of enclosure, Insulation Co-ordination studies, Calculation for touch and step potential, Equipotential earth mat drawings along with design calculation.  |          | ✓          |            | ✓                      |                       |
| 12.     | Study report of VFTO generated, Methodology for partial discharge detection, Design criteria regarding location of pressure relief devices, rupture diaphragms, Calculation to show no ferroresonance due to capacitance of GIS for voltage transformers, Design calculation for simulated parameters for seismic level, Measure to mitigate transient enclosure voltages by high frequency current. |          |            | ✓          | ✓                      |                       |


**VENDOR DATA REQUIREMENTS  
 FOR  
 220KV GIS PACKAGE**

| S. N. O. | DESCRIPTION  | WITH BID | POST ORDER |            |                        | REMARKS |
|----------|--|----------|------------|------------|------------------------|---------|
|          |  |          | FOR REVIEW | FOR RECORD | WITH DATA BOOK (FINAL) |         |
| 13.      | List of Recommended Spares, Commissioning Spares, Special Tools & Tackles  |          |            |            | ✓                      |         |
| 14.      | Data Books/ Manuals : Installation Manual, Operating/ Maintenance Manual, Catalogues/ Brochures, Equipment storage procedure at site |          |            |            | ✓                      |         |

**Notes :**

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Seven prints) and soft ( three CDs/DVDs ) in addition to submission through emails.
5. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
6. Post order- The schedule of drawing / data submission shall be mutually agreed between BHEL / EIL & the bidder during finalization of Document Control Index (DCI).
7. Bill of Material shall form part of the respective drawing.
- 8.
- 9.
10. All inspection related documents (QA/QC/ITP) shall be submitted to Third Party Inspection Agency (TPIA).
11. '\*' indicates the following
  - a. Equipments whose ITP is attached with Contract - ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

## Section-4, Annexure\_2

|   |   |   |   |   |                                      |
|---|---|---|---|---|--------------------------------------|
|  <b>ENGINEERS INDIA LIMITED</b><br>(A Govt. of India Undertaking) |   | <b>220kV GAS INSULATED SWITCHGEAR DATASHEET</b> |   | <b>Document No.</b><br>B269-999-16-50-DS-0031<br><b>Rev. No.</b> C<br>Page 1 of 5 |                                      |
| <b>Project</b>  | Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery |   |   | <b>Client</b>   | IOCL REFINERY DIVISION - HEAD OFFICE |
| <b>Unit</b>   | COMMON  | <b>Location</b>                                 | Panipat                                       | <b>Job No.</b>  | B269                                 |
|   |   |   |   | <b>Unit No.</b>   | 999                                  |
| <b>PURCHASER'S DATA</b>   |   |   |   |   |                                      |
| <b>A</b>  | <b>Site Conditions</b>  |   |   |   |                                      |
| 1   | Maximum Ambient Temperature   | °C  | 50  |   |                                      |
| 2   | Minimum Ambient Temperature   | °C  | 5   |   |                                      |
| 3   | Desian Ambient Temperature  | °C  | 45  |   |                                      |
| 4   | Relative Humiditv   | %   | 90  |   |                                      |
| 5   | Altitude Above MSL  | m   | 1000  |   |                                      |
| 6   | Environment   |   | Hot, Humid & Corrosive                        |   |                                      |
| <b>B</b>  | <b>Operating Conditions</b>   |   |   |   |                                      |
| 1   | System Voltage  |   | 220 kV ± TP %                                 |   |                                      |
| 2   | Frequency   |   | 50 Hz ± 3 %                                   |   |                                      |
| 3   | Number of Phases  |   | Three   |   |                                      |
| 4   | System Fault Level  |   | 50KA for 3 Sec                                |   |                                      |
| 5   | System Earthing   |   | Solidly Earthed                               |   |                                      |
| 6   | Auxilliary Power Supply   |   |   |   |                                      |
| i.  | - for space heaters,cubicle lamps etc   |   | 240 V AC TPN 10 %                             |   |                                      |
| ii  | - for protection metering and control   |   | 110 V DC -10/+ 15 %                           |   |                                      |
| iii   | - circuit breaker spring charging motor   |   | 110 V DC -10/+ 15 %                           |   |                                      |
| iv  | - Motor drive for disconnectors and earth switches                                      |   | 110 V DC -10/+ 15 %                           |   |                                      |
| v   | - high speed earth switch spring charging motor   |   | 110 V DC -10/+ 15 %                           |   |                                      |
| vi  | - gas handling and filling unit / cart  |   | 415 V AC TPN ± 10%                            |   |                                      |
| 7   | Installation  |   |   |   |                                      |
| i.  | GIS   |   | Airconditioned                                |   |                                      |
| ii  | LCC   |   | Airconditioned                                |   |                                      |
| iii   | CRP   |   | Airconditioned                                |   |                                      |
| <b>C</b>  | <b>Electrical Data</b>  |   |   |   |                                      |
| 1   | Bus Bar System  |   | Double  |   |                                      |
| 2   | Bus bar rated current   | A   | 2000  |   |                                      |
| 3   | 1 sec short circuit withstand capacity  | kA  | 50  |   |                                      |
| 4   | Rated peak withstand current  | kA  | 135   |   |                                      |
| 5   | Internal arc rating   |   | 50 kA for 0.3                                 |   |                                      |
| 6   | Circuit Breaker   |   |   |   |                                      |
| i   | Type of circuit breaker   |   | SF6   |   |                                      |
| ii  | Duty cycle of Circuit Breaker   |   | 0-3 min-CO-3 min-CO                           |   |                                      |
| iii   | Breaking capacity   | kA  | 50  |   |                                      |
| iv  | Making capacity   | kA  | 135   |   |                                      |
| v   | CB Operating Mechanism  |   | Spring Charged or Electro Hydraulic 6-51-0066 |   |                                      |
| vi  | Shunt trip coil-1   |   | 110V DC                                       |   |                                      |
|   | Shunt trip coil -2  |   | 110V DC                                       |   |                                      |
| vii   | Mechanical indicator for breaker status   |   | Required                                      |   |                                      |
| viii  | Pre-insertion resistor  |   | Not Required                                  |   |                                      |
| 7   | Disconnector & Earthing Switch  |   |   |   |                                      |
| i   | Operating Machanism   |   | Motorised                                     |   |                                      |
| ii  | Mechanical indicator for disconnector & earthswitch status                              |   | Required                                      |   |                                      |
| iii   | Viewing windows for disconnector and earthswitch  |   | Required                                      |   |                                      |
| iv  | Mechanical interlock for disconnector & earthswitch                                     |   | Required                                      |   |                                      |
| v   | Electrical interlock with associated circuit breaker                                    |   | Required                                      |   |                                      |
| 8   | High speed make-proof Earthing switch   |   |   |   |                                      |
|   |   |   |   |   |                                      |
|   |   |   |   |   |                                      |
| C   | 27-SEP-2021   | REVISED AND REISSUED WITH TENDER                | ANIL KUMAR GARHWAL                            | HARISH KUMAR  | HARISH KUMAR                         |
| B   | 05-JUL-2021   | REVISED AND REISSUED WITH TENDER                | ANIL KUMAR GARHWAL                            | HARISH KUMAR  | HARISH KUMAR                         |
| A   | 12-MAY-2020   | ISSUED WITH TENDER                              | ANIL KUMAR GARHWAL                            | HARISH KUMAR  | HARISH KUMAR                         |
| Rev. No.  | Date  | Purpose   | Prepared By                                   | Reviewed By   | Approved By                          |

|                            |   |                                  |                    |  |                                      |
|----------------------------|---|----------------------------------|--------------------|--|--------------------------------------|
| <b>Project</b>             | Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery |                                  |                    | <b>Client</b>                              | IOCL REFINERY DIVISION - HEAD OFFICE |
| <b>Unit</b>                | COMMON  | <b>Location</b>                  | Panipat            | <b>Job No.</b>                             | B269                                 |
|                            |   |                                  |                    | <b>Unit No.</b>                            | 999                                  |
| i                          | Operating Mechanism   |                                  |                    | Motorised                                  |                                      |
| ii                         | Mechanical indicator for High speed earthswitch status                                  |                                  |                    | Required                                   |                                      |
| iii                        | Electrical interlock with associated circuit breaker                                    |                                  |                    | Required                                   |                                      |
| <b>D</b>                   | <b>Miscellaneous</b>  |                                  |                    |  |                                      |
| 1                          | Paint Shade   |                                  |                    | RAL-7032                                   |                                      |
| 2                          | Interface with ECS  |                                  |                    | Required                                   |                                      |
| 3                          | SF6 Gas monitoring system   |                                  |                    | Required                                   |                                      |
| 4                          | SF6 Gas Handling /filling unit  |                                  |                    | Required                                   |                                      |
| 5                          | Spare SF6 gas   |                                  |                    | Required                                   |                                      |
| 6                          | Quality of spare gas  |                                  |                    | 10% of total gas as per 6.9.4 of 6-51-0066 |                                      |
| 7                          | Mimic on LV compartment   |                                  |                    | Required                                   |                                      |
| 8                          | Voltage Detectors   |                                  |                    | Required                                   |                                      |
| <b>MANUFACTURER'S DATA</b> |   |                                  |                    |  |                                      |
| <b>A</b>                   | <b>General</b>  |                                  |                    |  |                                      |
| 1                          | Name of manufacture   |                                  |                    |  |                                      |
| 2                          | Place of manufacture  |                                  |                    |  |                                      |
| 3                          | Type designation  |                                  |                    |  |                                      |
| 4                          | LCC   |                                  |                    |  |                                      |
| 5                          | Degree of protection  |                                  |                    |  |                                      |
| i                          | Gas compartment   |                                  |                    |  |                                      |
| ii                         | LCC   |                                  |                    |  |                                      |
| iii                        | CRP   |                                  |                    |  |                                      |
| 6                          | Enclosure   |                                  |                    |  |                                      |
| 7                          | Enclosure material  |                                  |                    |  |                                      |
| i                          | Gas compartment   |                                  |                    |  |                                      |
| ii                         | LCC   |                                  |                    |  |                                      |
| iii                        | CRP   |                                  |                    |  |                                      |
| 9                          | Rated Voltage   |                                  |                    | kV   |                                      |
| 10                         | 1 min. power frequency withstand (rms)  |                                  |                    | kV   |                                      |
| 11                         | Lighting impulse withstand voltage  |                                  |                    | kV   |                                      |
| 12                         | Switching impulse withstand voltage   |                                  |                    |  |                                      |
| 13                         | Rated current   |                                  |                    |  |                                      |
| i                          | Busbar  |                                  |                    | A  |                                      |
| ii                         | Incomers and outgoing feeders   |                                  |                    | A  |                                      |
| 14                         | 1 sec short ckt. withstand capacity   |                                  |                    | kA   |                                      |
| 15                         | Peak dynamic withstand capacity   |                                  |                    | kA   |                                      |
| 16                         | Bus bar material  |                                  |                    |  |                                      |
| 17                         | Main Busbar size  |                                  |                    |  |                                      |
| 18                         | Bus bar size for incomers and outgoing feeders  |                                  |                    | sqmm                                       |                                      |
| 19                         | Insulating material (busbar support)  |                                  |                    |  |                                      |
| 20                         | Eath busbar material / size   |                                  |                    | sqmm                                       |                                      |
| <b>B</b>                   | <b>SF6 Gas</b>  |                                  |                    |  |                                      |
| 1                          | Average leakage rate of SF6 gas   |                                  |                    | % / year                                   |                                      |
| 2                          | Gas monitoring devices (density quaques/pressure switch)                                |                                  |                    |  |                                      |
| 3                          | Gas handling and filling arrangement /cart  |                                  |                    |  |                                      |
|                            | - maximum power requirement   |                                  |                    | kW   |                                      |
| 4                          | Whether GIS are dispatched filled with SF6 gas  |                                  |                    |  |                                      |
|                            |   |                                  |                    |  |                                      |
| C                          | 27-SEP-2021   | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR                               | HARISH KUMAR                         |
| B                          | 05-JUL-2021   | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR                               | HARISH KUMAR                         |
| A                          | 12-MAY-2020   | ISSUED WITH TENDER               | ANIL KUMAR GARHWAL | HARISH KUMAR                               | HARISH KUMAR                         |
| Rev. No.                   | Date  | Purpose                          | Prepared By        | Reviewed By                                | Approved By                          |

|                |   |                 |               |                                      |      |
|----------------|---|-----------------|---------------|--------------------------------------|------|
| <b>Project</b> | Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery |                 | <b>Client</b> | IOCL REFINERY DIVISION - HEAD OFFICE |      |
| <b>Unit</b>    | COMMON  | <b>Location</b> | Panipat       | <b>Job No.</b>                       | B269 |
|                |   |                 |               | <b>Unit No.</b>                      | 999  |
| 5              | SF6 gas pressure for each gas compartment   |                 |               |                                      |      |
| i              | Design Pressure   |                 |               |                                      |      |
| ii             | Operating Pressure  |                 |               |                                      |      |
| iii            | Alarm Pressure  |                 |               |                                      |      |
| iv             | Lockout Pressure  |                 |               |                                      |      |
| 6              | Pressure of relief device   |                 |               |                                      |      |
| 7              | Spare gas (no. of cylinders,volume/pressure of cylinder)                                |                 |               |                                      |      |
| <b>C</b>       | <b>Circuit Breaker</b>  |                 |               |                                      |      |
| 1              | Type of circuit breaker   | SF6             |               |                                      |      |
| 2              | Make  |                 |               |                                      |      |
| 3              | Place of manufacture  |                 |               |                                      |      |
| 4              | Type designation  |                 |               |                                      |      |
| 5              | Encloser  |                 |               |                                      |      |
| 6              | Number of poles per phase   |                 |               |                                      |      |
| 7              | Number of interrupting chambers per pole  |                 |               |                                      |      |
| 8              | Number of trip coils  |                 |               |                                      |      |
| 9              | Rated continuous current for I/C and O/G fdrs   |                 |               |                                      |      |
| 10             | Duty cycle  |                 |               |                                      |      |
| 11             | CB Operating mechanism  |                 |               |                                      |      |
| 12             | Short circuit withstand capacity  | kA              |               |                                      |      |
| 13             | Breaking capacity   | kA              |               |                                      |      |
| 14             | Peak making capacity  | kA              |               |                                      |      |
| 15             | % DC component  |                 |               |                                      |      |
| 16             | First pole to clear factor  |                 |               |                                      |      |
| 17             | Power required for opening  | W               |               |                                      |      |
| 18             | Power required for closing  | W               |               |                                      |      |
| 19             | Power required for spring charging motor  | W               |               |                                      |      |
| 20             | Closing time  | sec             |               |                                      |      |
| 21             | Opening time  | sec             |               |                                      |      |
| 22             | Provision of manual spring charging   |                 |               |                                      |      |
| 23             | Manual trip device  |                 |               |                                      |      |
| 24             | Mechanical ON/OFF indicator for breaker   |                 |               |                                      |      |
| 25             | Mechanical indication for spring status   |                 |               |                                      |      |
| 26             | Operation counter   |                 |               |                                      |      |
| 27             | Number of auxiliary contacts and their rating   |                 |               |                                      |      |
| 28             | Breaker is trip free  |                 |               |                                      |      |
| <b>D</b>       | <b>Disconnecter / Earthing switch</b>   |                 |               |                                      |      |
| 1              | Make  |                 |               |                                      |      |
| 2              | Place of manufacture  |                 |               |                                      |      |
| 3              | Type designation  |                 |               |                                      |      |
| 4              | Rated continuous current of disconnector/earth switch for I/C and O/G fdr               |                 |               |                                      |      |
| 5              | Short circuit withstand capacity  |                 |               |                                      |      |
| 6              | Short circuit making capacity of high speed earth switch                                |                 |               |                                      |      |
| 7              | Operating mechanism   |                 |               |                                      |      |
| 8              | Type of motor drive   |                 |               |                                      |      |

| Rev. No. | Date        | Purpose                          | Prepared By        | Reviewed By  | Approved By  |
|----------|-------------|----------------------------------|--------------------|--------------|--------------|
| C        | 27-SEP-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| B        | 05-JUL-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH TENDER               | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |

**Project** Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery **Client** IOCL REFINERY DIVISION - HEAD OFFICE

**Unit** COMMON **Location** Panipat **Job No.** B269 **Unit No.** 999

|          |  |    |
|----------|--|----|
| 9        | Number of auxiliary contacts and their rating                |    |
| 10       | Mechanical ON/OFF indicator                                  |    |
| 11       | Manual operation handle                                      |    |
| 12       | Manual spring charging                                       |    |
| 13       | Power required for spring charging motor                     |    |
| <b>E</b> | <b>Instrument Transformers</b>                               |    |
| 1        | Current Transformer  |    |
| i        | Make   |    |
| ii       | Place of manufacture   |    |
| iii      | Type designation   |    |
| iv       | CT ratio, accuracy & VA burden                               |    |
| v        | Knee point voltage / secondary voltage, accuracy & VA burden |    |
| 2        | Voltage Transformer  |    |
| i        | Make   |    |
| ii       | Place of manufacture   |    |
| iii      | Type designation   |    |
| iv       | Primary Voltage / Secondary Voltage ,accuracy & VA burden    |    |
| <b>F</b> | <b>Surge Arrestors</b>                                       |    |
| 1        | Make   |    |
| 2        | Type designation   |    |
| 3        | Place of manufacture   |    |
| 4        | Rated Voltage  | kV |
| 5        | MCOV(Max. Continuous voltage, accuracy & VA burden)          | kV |
| 6        | Line discharge class   | kA |
| 7        | Nominal discharge current                                    | kA |
| 8        | High current withstand capacity                              | kA |
| 9        | Temporary overvoltage for 1 sec                              |    |
| 10       | Temporary overvoltage for 10 sec                             |    |
| <b>G</b> | <b>Mechanical</b>  |    |
| 1        | Feeder / Bay   |    |
|          | Max. overall weight  |    |
|          | overall Dimensions(Width X Depth X Height)                   |    |
| 2        | LCC  |    |
|          | overall Dimensions(Width X Depth X Height)                   |    |
| 3        | CRP  |    |
|          | overall Dimensions(Width X Depth X Height)                   |    |
| 4.       | Largest shipping section                                     |    |
|          | Max overall weight   |    |
|          | overall Dimensions(Width X Depth X Height)                   |    |
| 5        | Gas handling & filling plant / service cart                  |    |
|          | Overall dimensions(Width X Depth X Height)                   |    |
| 6        | Recommended clearances                                       |    |
|          | GIS (Front / rear / above)                                   | mm |
|          | LCC (Front / rear / above)                                   | mm |
|          | CRP (Front / rear / above)                                   | mm |

|          |             |                                  |                    |              |              |
|----------|-------------|----------------------------------|--------------------|--------------|--------------|
| C        | 27-SEP-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| B        | 05-JUL-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH TENDER               | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| Rev. No. | Date        | Purpose                          | Prepared By        | Reviewed By  | Approved By  |

**Project** Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery **Client** IOCL REFINERY DIVISION - HEAD OFFICE

**Unit** COMMON **Location** Panipat **Job No.** B269 **Unit No.** 999

|          |  |  |
|----------|--|--|
| 7        | Shock loading on foundation  |  |
| 8        | Requirement of EOT crane for GIS   |  |
| 9        | Capacity of EOT crane required   |  |
| 10       | Clear height recommended for EOT crane   |  |
| 11       | Dispatch for each feeder / bay   |  |
| <b>H</b> | <b>Copies of following test certificates encl</b>                                      |  |
|          | For each type of offered feeder/bay with circuit breaker, disconnector and earthswitch |  |
| 1        | Short circuit tests(peak and 1 sec withstand)  |  |
| 2        | Making and breaking tests  |  |
| 3        | Temperature rise test  |  |
| 4        | Internal arc test  |  |
| 5.       | Dielectric tests   |  |
| 6        | Operation and mechanical endurance tests   |  |

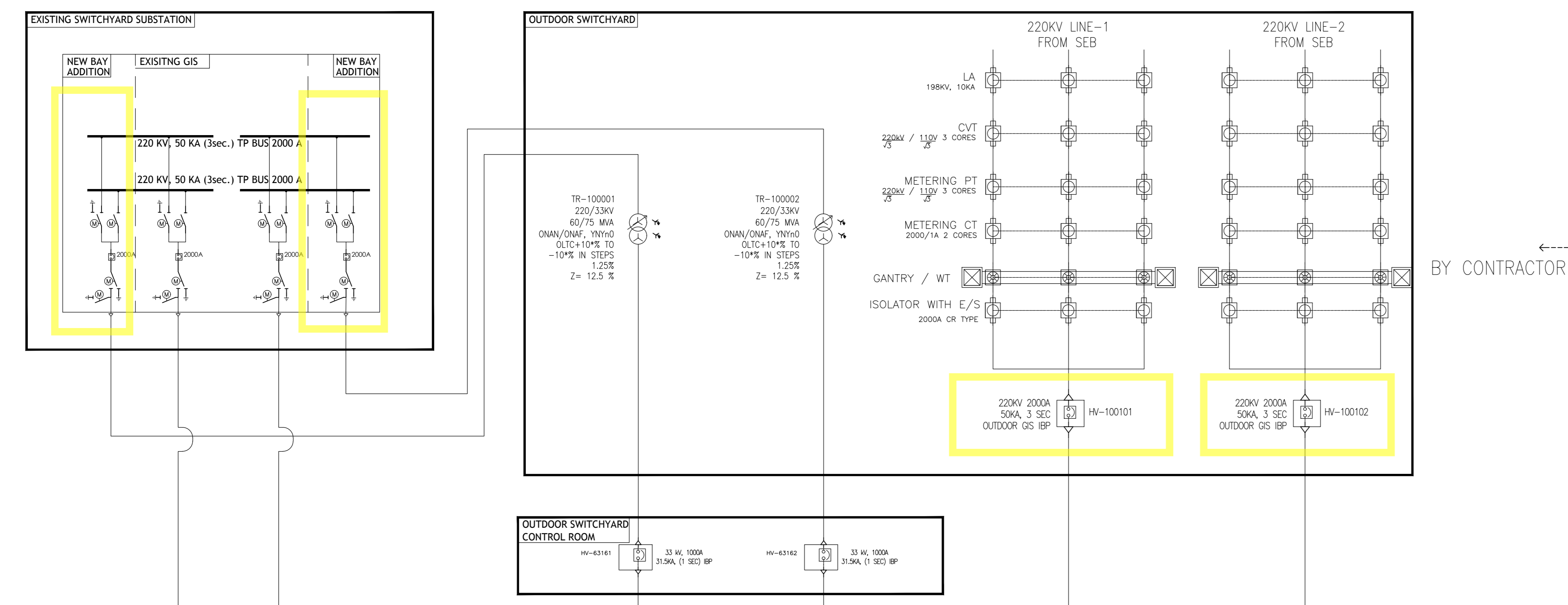
**Notes**

- 1 Disconnector class shall be M2.
- 2 Rated line charging interrupting current of breaker shall be as per IEC on light loaded line and 4KM of cable.
- 3 Following equipments shall be supplied along with GIS:
  - a) SF6 Gas Leakage Detector
  - b) Gas Filling and Evacuation Cart
  - c) SF6 Gas Analyser
  - d) Online Partial Discharge (PD) Monitoring System along with all software and hardware as required
  - e) Online SF6 Gas filling system
- 4 Although the equipment shall be installed in Air Conditioned GIS/ Switchgear hall, but same shall be suitable for installation and satisfactory operation in a non air conditioned, tropical, humid and corrosive environment.

|          |             |                                  |                    |              |              |
|----------|-------------|----------------------------------|--------------------|--------------|--------------|
| C        | 27-SEP-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| B        | 05-JUL-2021 | REVISED AND REISSUED WITH TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH TENDER               | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| Rev. No. | Date        | Purpose                          | Prepared By        | Reviewed By  | Approved By  |

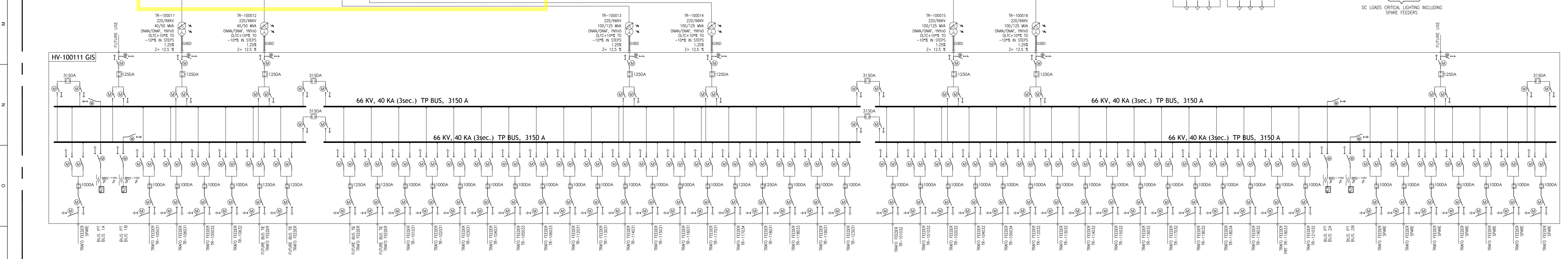
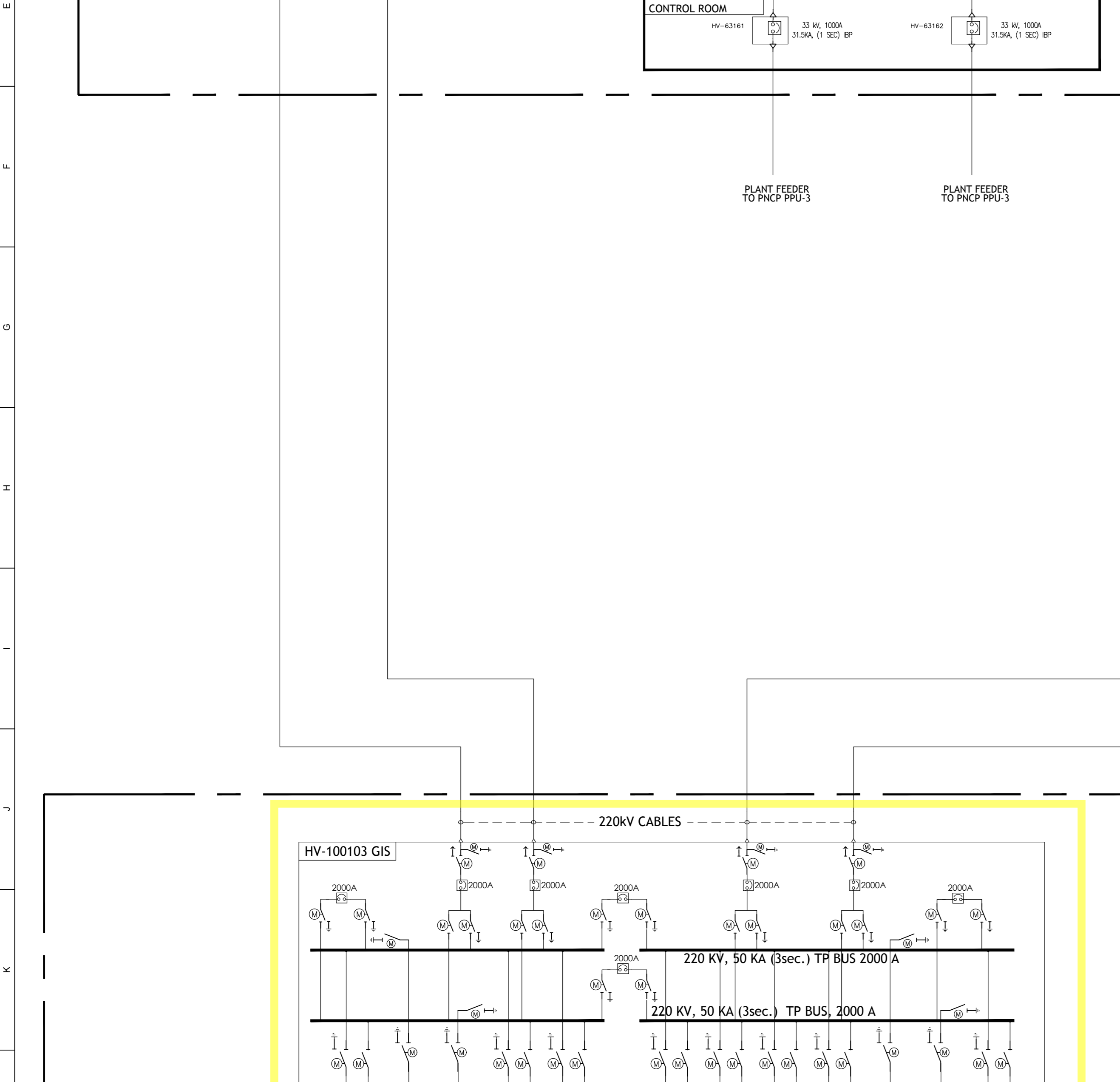
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LOC : EXISTING REFINERY AREA

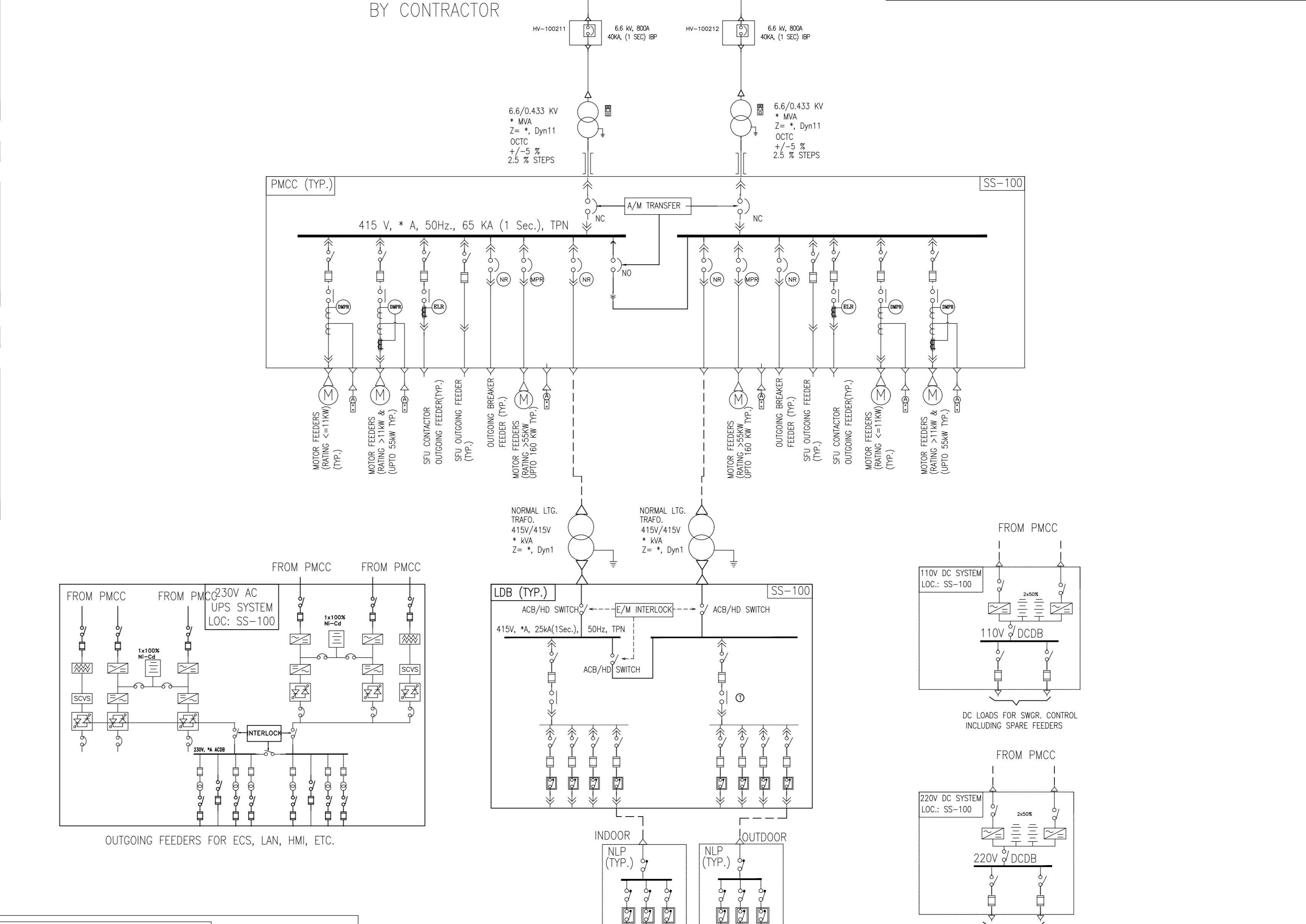


BY OWNER/OTHERS  
BY CONTRACTOR

PLANT FEEDERS TO PNCV PDU-3



SUBSTATION - 100



LOC : P25 NEW REFINERY AREA

| REF. DWG. NO. | REFERENCE DRAWING TITLE |
|---------------|-------------------------|
|               |                         |
|               |                         |
|               |                         |
|               |                         |
|               |                         |
|               |                         |

**NOTES :-**

1. THIS SINGLE LINE DIAGRAM IS INDICATIVE ONLY. IT IS INTENDED TO HIGHLIGHT THE POWER DISTRIBUTION PHILOSOPHY AND BROADLY DEFINE THE MAJOR ELECTRICAL EQUIPMENTS. THE EXACT DETAILS OF EQUIPMENT SHALL BE FINALISED DURING DETAILED ENGINEERING AS PER PROJECT SPECIFICATIONS.
2. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO DEVELOP THE SINGLE LINE DIAGRAM INTO DETAILED DIAGRAM BASED ON BID PACKAGE REQUIREMENTS.
3. THE RATING & QUANTITY OF ELECTRICAL EQUIPMENT SHOWN IN THE SINGLE LINE DIAGRAM ARE INDICATIVE. THE QUANTITIES & RATING OF THESE EQUIPMENTS SHALL BE DECIDED & FINALISED DURING DETAIL ENGINEERING MEETING AS PER BID PACKAGE REQUIREMENT WITH NO COST AND TIME IMPLICATION.
4. TYPICAL OUTGOING FEEDERS ARE SHOWN IN FOR ALL SWITCHYARDS. REQUIRED NUMBER OF OUTGOING FEEDERS INCLUDING SPARES AS PER ENGINEERING DESIGN BASIS AND JOB SPECIFICATION SHALL BE PROVIDED BY THE CONTRACTOR IN LINE WITH BID DOCUMENT.
5. RELAYS, METERS AND OTHER COMPONENTS SHALL BE PROVIDED FOR FEEDERS AS PER FEEDER DATASHEETS. RESPECTIVE FEEDER HARDWARE DATASHEETS, ENGINEERING DESIGN BASIS & JOB SPECIFICATION ENCLOSED WITH THE BID DOCUMENT.
6. ANY OTHER EQUIPMENT AS REQUIRED FOR MEETING STATUTORY REQUIREMENT SHALL BE PROVIDED BY CONTRACTOR.
7. SCOPE LINE, MARKED ON THE KEY SLD IS INDICATIVE AND DOES NOT DEFINE TOTAL ELECTRICAL SCOPE OF CONTRACTOR FOR THE PACKAGE. FOR DETAILED SCOPE, REFER BID DOCUMENT AND OTHER DRAWINGS.

**LEGENDS**

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| REV. | DATE     | REVISIONS                             | BY  | CHKD | APPD | PENCK |
|------|----------|---------------------------------------|-----|------|------|-------|
| C    | 09.09.21 | REVISED AND REISSUED WITH BID PACKAGE | AKS | HK   | HK   |       |
| B    | 03.07.21 | REVISED AND REISSUED WITH BID PACKAGE | AKS | HK   | HK   |       |
| A    | 12.05.20 | ISSUED WITH BID PACKAGE               | AKS | HK   | HK   |       |

**ENGINEERS INDIA LIMITED**  
(A Govt. of India Undertaking)

INDIAN OIL CORPORATION LTD.

PANIPAT REFINERY EXPANSION PROJECT (P-25)

KEY SINGLE LINE DIAGRAM  
220KV GIS PACKAGE (SS-100)

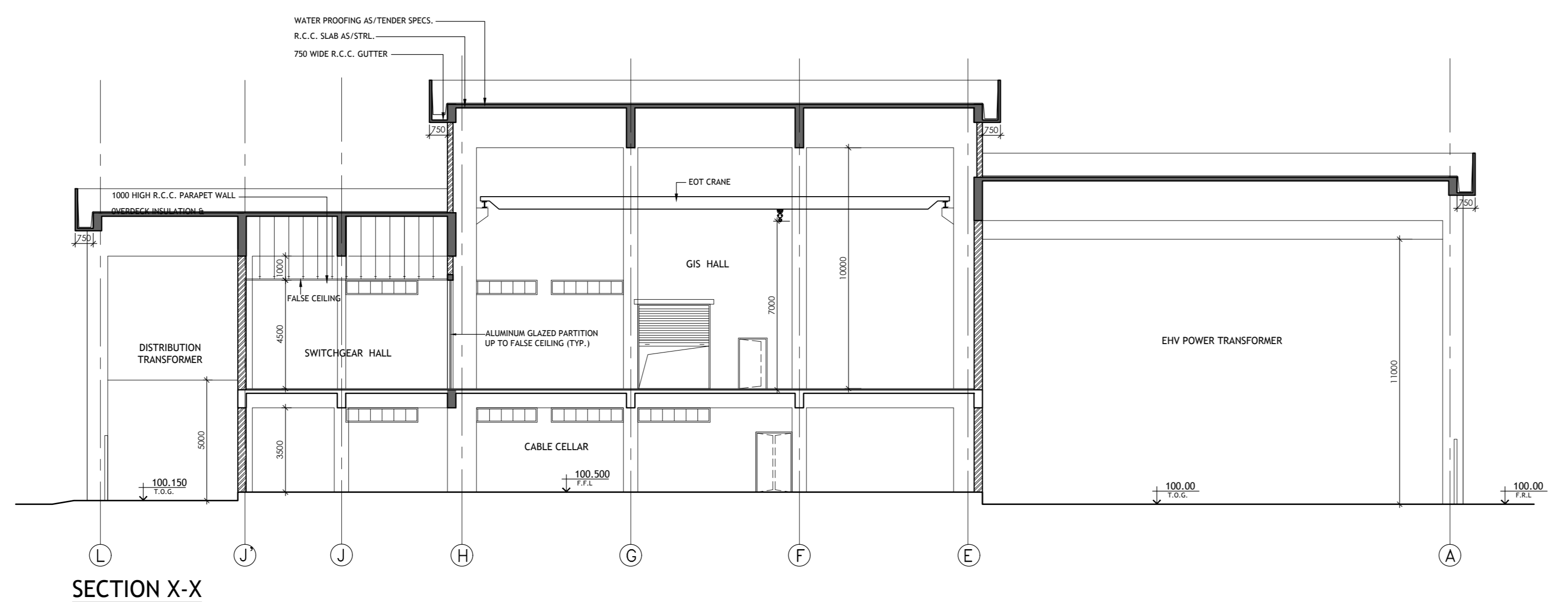
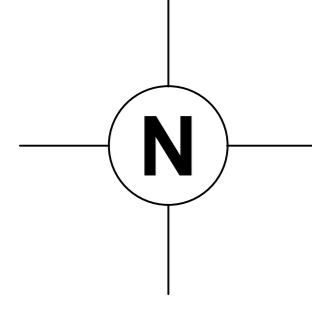
|       |         |      |      |      |          |      |
|-------|---------|------|------|------|----------|------|
| SCALE | JOB NO. | UNIT | DIVN | DEPT | DWG. NO. | REV. |
| NTS   | B269    | 99   | 16   | 50   | 002100   | C    |

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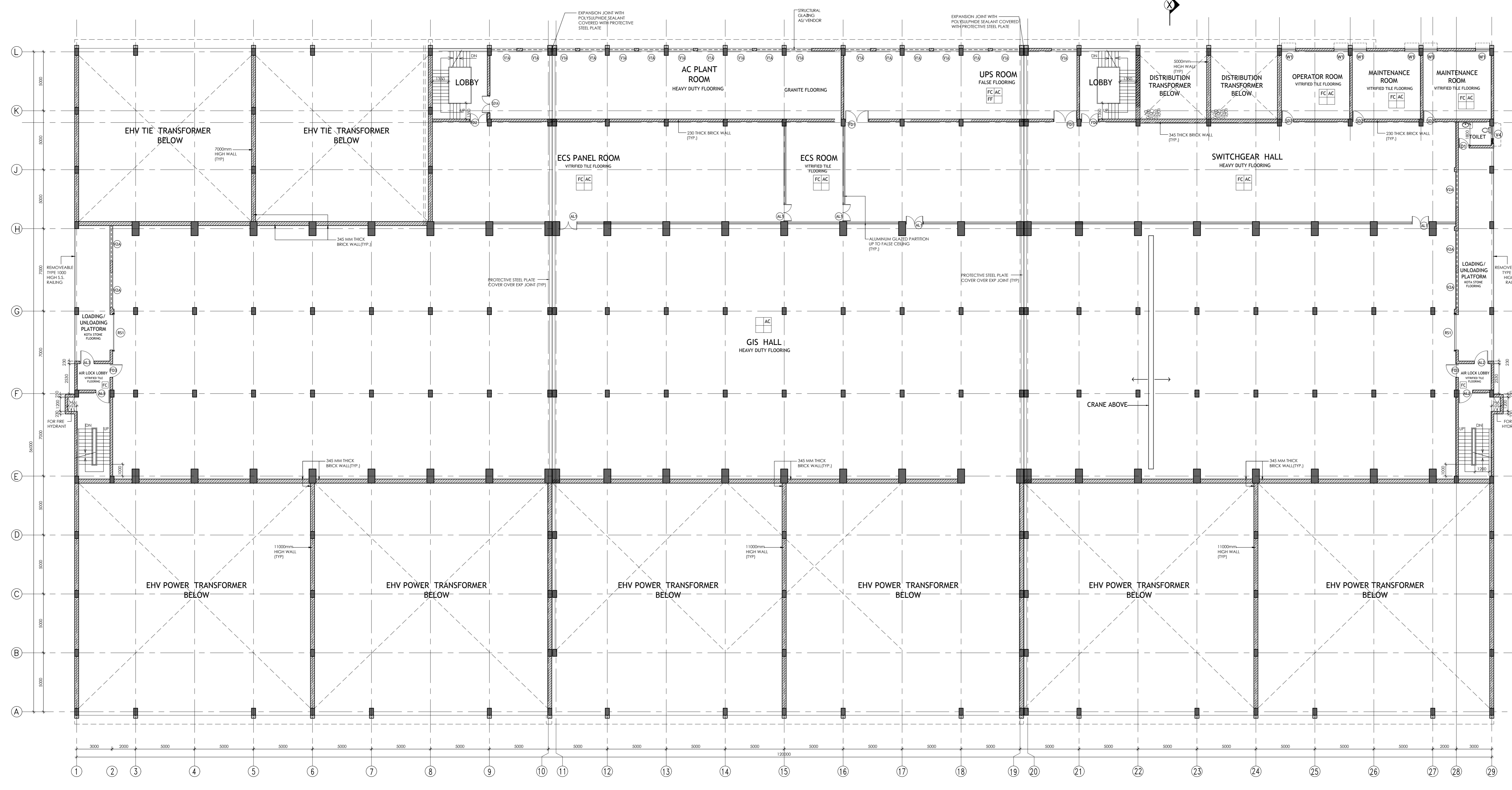
यह दस्तावेज़ केवल इंजीनियरिंग डिजाइन के लिए है और इसे कानून के तहत सुरक्षित रखना चाहिए। इस दस्तावेज़ को कहीं भी प्रकाशित नहीं किया जा सकता है।  
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B269-000-81-41-02407



SECTION X-X



FIRST FLOOR PLAN

| REF. DWG. NO.        | REFERENCE DRAWING TITLE           |
|----------------------|-----------------------------------|
| B269-000-81-41-02406 | SUBSTATION-100- GROUND FLOOR PLAN |

- NOTES :-
1. ALL DIMENSIONS ARE IN MILLIMETRES.
  2. ALL LEVELS ARE IN METRES.
  3. LEVEL 100.00 INDICATES FINISHED APPROACH ROAD LEVEL NEAR THE BUILDING.
  4. UNDERDECK INSULATION SHALL BE PROVIDED UNDER THE ROOF OF ALL AC AREAS AND A.H.U. ROOM.
  5. ALL OUTSIDE SURFACES SHALL BE FINISHED WITH 18MM. THK. PLAIN CEMENT PLASTER ON BRICK SURFACES & 6MM. THK. PLAIN CEMENT PLASTER ON R.C.C. SURFACES, EXCEPT WHERE SAND FACE PLASTER IS MENTIONED.
  6. ALL INTERNAL WALLS SHALL BE FINISHED WITH 12MM THK. PLAIN CEM. PLASTER ON PERIPHERAL WALLS & 12MM/15MM THK. PLAIN CEM. PLASTER ON EITHER SIDE OF INTERNAL WALLS. 6MM THK. PLAIN CEMENT PLASTER SHALL BE PROVIDED ON R.C.C. SURFACES.
  7. ALL CUTOUPS IN FLOOR, WALLS FOR CABLE ENTRIES ETC. TO BE KEPT AS/REQUIREMENT OF RESPECTIVE DEPTTS.
  8. 1000 WIDE PLINTH PROTECTION WITH BUILDING DRAIN SHALL BE PROVIDED ALL AROUND THE BUILDING.
  9. ALL SUNSHADE, CANOPY & ROOF PROJECTIONS SHALL HAVE DRIP MOULD GROOVES UNDERLATH ALL ALONG THE PERIPHERIES.
  10. SUITABLE SLOPE IN FLOOR SLAB FOR CABLE CELLAR AND A/C PACKAGE ROOM SHALL BE PROVIDED TOWARDS FLOOR TRAPS LOCATIONS AS SHOWN IN THE DRG. FOR DRAINAGE OF WATER.
  11. SUBSTATION SWITCHGEAR HALL SHALL BE AIR - CONDITIONED.
  12. SUBSTATION SWITCHGEAR HALL SHALL HAVE CLEAR HEIGHT OF 4.5M.
  13. ALL DOORS REQUIRED IN AC AREAS SHALL BE AIR - TIGHT.
  14. FOR INTERNAL AND EXTERNAL FINISHES, ENGINEERING DESIGN BASIS SHALL BE REFERRED.
  15. THE SIZE OF BUILDING AND ROOMS SHOWN ARE THE MINIMUM AND INDICATIVE. THEY SHALL BE FINALIZED AND INCREASED AS PER REQUIREMENT DURING DETAILED ENGINEERING.

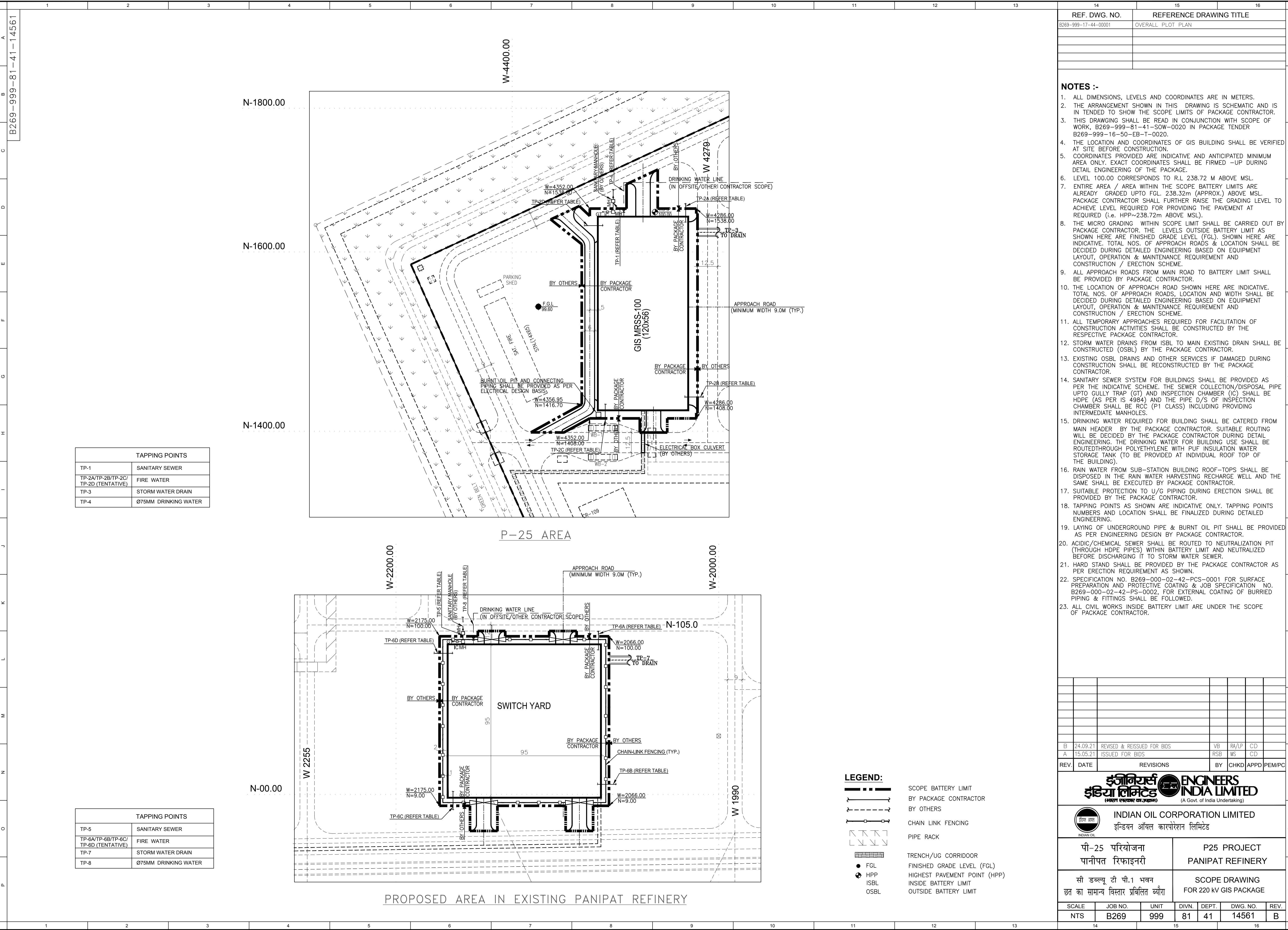
LEGEND :-

|        |                        |
|--------|------------------------|
| F.R.L. | - FINISHED ROAD LEVEL  |
| F.F.L. | - FINISHED FLOOR LEVEL |
| FC     | - FALSE CEILING        |
| AC     | - AIR CONDITIONED      |
| FF     | - FALSE FLOORING       |

|   |   |
|---|---|
|   |   |
| <b>इंडियन ऑयल कॉर्पोरेशन लिमिटेड</b><br>INDIAN OIL CORPORATION LTD. |   |
| पी25 प्रोजेक्ट<br>पानीपत रिफाइनरी                                   | P25 PROJECT<br>PANIPAT REFINERY   |
| सब स्टेशन 100<br>प्लान एवं काट                                      | SUBSTATION-100<br>(MAIN RECEIVING SUBSTATION)<br>FIRST FLOOR PLAN & SECTION |
| SCALE: 1:100  | JOB NO.: B/2/6/9/0/0/0<br>DIVN: 8   DEPT: 1   DWG. NO.: 4102407   REV: B    |

प्रकृत आरेख एवं सभी विवरण इंजीनियरिंग विभाग लिमिटेड की संपत्ति हैं। ये बिना अनुमति के किसी भी व्यक्ति को प्रकृत आरेख का उपयोग करने से प्रतिबंधित हैं। प्रकृत आरेख का उपयोग करने से पूर्व लिखित अनुमति लेना आवश्यक है।  
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प्रस्तुत आरेख एवं इसमें विहित डिजाइन इंजीनियरिंग डिवीजमेंट की संतुष्टि है। ये मात्र उधार दिए गए हैं और उधारकर्ता ने यह स्पष्ट समझना कि यह न हो उड़े पुनः मुद्रित किया जाएगा, न मकल की जाएगी, न उधार दिए जाएंगे, न प्रकीर्ण किए जाएंगे और न ही सीमित और निजी प्रयोग के अलावा इकाई को अन्य प्रयोग हेतु और यह उधार देने वाले द्वारा उधारकर्ता को लिखित रूप में दी गई शर्तों से होगा।  
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| TAPPING POINTS                      |                      |
|-------------------------------------|----------------------|
| TP-1                                | SANITARY SEWER       |
| TP-2A/TP-2B/TP-2C/TP-2D (TENTATIVE) | FIRE WATER           |
| TP-3                                | STORM WATER DRAIN    |
| TP-4                                | Ø75MM DRINKING WATER |

| TAPPING POINTS                      |                      |
|-------------------------------------|----------------------|
| TP-5                                | SANITARY SEWER       |
| TP-6A/TP-6B/TP-6C/TP-6D (TENTATIVE) | FIRE WATER           |
| TP-7                                | STORM WATER DRAIN    |
| TP-8                                | Ø75MM DRINKING WATER |

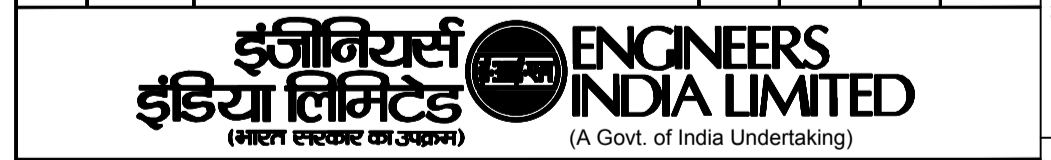
**LEGEND:**

|  |                              |
|--|------------------------------|
|  | SCOPE BATTERY LIMIT          |
|  | BY PACKAGE CONTRACTOR        |
|  | BY OTHERS                    |
|  | CHAIN LINK FENCING           |
|  | PIPE RACK                    |
|  | TRENCH/UG CORRIDOR           |
|  | FINISHED GRADE LEVEL (FGL)   |
|  | HIGHEST PAVEMENT POINT (HPP) |
|  | INSIDE BATTERY LIMIT         |
|  | OUTSIDE BATTERY LIMIT        |

| REF. DWG. NO.       | REFERENCE DRAWING TITLE |
|---------------------|-------------------------|
| B269-999-17-44-0001 | OVERALL PLOT PLAN       |

- NOTES :-**
- ALL DIMENSIONS, LEVELS AND COORDINATES ARE IN METERS.
  - THE ARRANGEMENT SHOWN IN THIS DRAWING IS SCHEMATIC AND IS INTENDED TO SHOW THE SCOPE LIMITS OF PACKAGE CONTRACTOR.
  - THIS DRAWING SHALL BE READ IN CONJUNCTION WITH SCOPE OF WORK, B269-999-81-41-SOW-0020 IN PACKAGE TENDER B269-999-16-50-EB-T-0020.
  - THE LOCATION AND COORDINATES OF GIS BUILDING SHALL BE VERIFIED AT SITE BEFORE CONSTRUCTION.
  - COORDINATES PROVIDED ARE INDICATIVE AND ANTICIPATED MINIMUM AREA ONLY. EXACT COORDINATES SHALL BE FIRMED UP DURING DETAIL ENGINEERING OF THE PACKAGE.
  - LEVEL 100.00 CORRESPONDS TO R.L. 238.72 M ABOVE MSL.
  - ENTIRE AREA / AREA WITHIN THE SCOPE BATTERY LIMITS ARE ALREADY GRADED UP TO FGL. 238.32m (APPROX.) ABOVE MSL. PACKAGE CONTRACTOR SHALL FURTHER RAISE THE GRADING LEVEL TO ACHIEVE LEVEL REQUIRED FOR PROVIDING THE PAVEMENT AT REQUIRED (i.e. HPP~238.72m ABOVE MSL).
  - THE MICRO GRADING WITHIN SCOPE LIMIT SHALL BE CARRIED OUT BY PACKAGE CONTRACTOR. THE LEVELS OUTSIDE BATTERY LIMIT AS SHOWN HERE ARE FINISHED GRADE LEVEL (FGL). SHOWN HERE ARE INDICATIVE. TOTAL NOS. OF APPROACH ROADS & LOCATION SHALL BE DECIDED DURING DETAILED ENGINEERING BASED ON EQUIPMENT LAYOUT, OPERATION & MAINTENANCE REQUIREMENT AND CONSTRUCTION / ERECTION SCHEME.
  - ALL APPROACH ROADS FROM MAIN ROAD TO BATTERY LIMIT SHALL BE PROVIDED BY PACKAGE CONTRACTOR.
  - THE LOCATION OF APPROACH ROAD SHOWN HERE ARE INDICATIVE. TOTAL NOS. OF APPROACH ROADS, LOCATION AND WIDTH SHALL BE DECIDED DURING DETAILED ENGINEERING BASED ON EQUIPMENT LAYOUT, OPERATION & MAINTENANCE REQUIREMENT AND CONSTRUCTION / ERECTION SCHEME.
  - ALL TEMPORARY APPROACHES REQUIRED FOR FACILITATION OF CONSTRUCTION ACTIVITIES SHALL BE CONSTRUCTED BY THE RESPECTIVE PACKAGE CONTRACTOR.
  - STORM WATER DRAINS FROM ISBL TO MAIN EXISTING DRAIN SHALL BE CONSTRUCTED (OSBL) BY THE PACKAGE CONTRACTOR.
  - EXISTING OSBL DRAINS AND OTHER SERVICES IF DAMAGED DURING CONSTRUCTION SHALL BE RECONSTRUCTED BY THE PACKAGE CONTRACTOR.
  - SANITARY SEWER SYSTEM FOR BUILDINGS SHALL BE PROVIDED AS PER THE INDICATIVE SCHEME. THE SEWER COLLECTION/DISPOSAL PIPE UPTO GULLY TRAP (GT) AND INSPECTION CHAMBER (IC) SHALL BE HDPE (AS PER IS 4984) AND THE PIPE D/S OF INSPECTION CHAMBER SHALL BE RCC (P1 CLASS) INCLUDING PROVIDING INTERMEDIATE MANHOLES.
  - DRINKING WATER REQUIRED FOR BUILDING SHALL BE CATERED FROM MAIN HEADER BY THE PACKAGE CONTRACTOR. SUITABLE ROUTING WILL BE DECIDED BY THE PACKAGE CONTRACTOR DURING DETAIL ENGINEERING. THE DRINKING WATER FOR BUILDING USE SHALL BE ROUTED THROUGH POLYETHYLENE WITH PUF INSULATION WATER STORAGE TANK (TO BE PROVIDED AT INDIVIDUAL ROOF TOP OF THE BUILDING).
  - RAIN WATER FROM SUB-STATION BUILDING ROOF-TOPS SHALL BE DISPOSED IN THE RAIN WATER HARVESTING RECHARGE WELL AND THE SAME SHALL BE EXECUTED BY PACKAGE CONTRACTOR.
  - SUITABLE PROTECTION TO U/G PIPING DURING ERECTION SHALL BE PROVIDED BY THE PACKAGE CONTRACTOR.
  - TAPPING POINTS AS SHOWN ARE INDICATIVE ONLY. TAPPING POINTS NUMBERS AND LOCATION SHALL BE FINALIZED DURING DETAILED ENGINEERING.
  - LAYING OF UNDERGROUND PIPE & BURNT OIL PIT SHALL BE PROVIDED AS PER ENGINEERING DESIGN BY PACKAGE CONTRACTOR.
  - ACIDIC/CHEMICAL SEWER SHALL BE ROUTED TO NEUTRALIZATION PIT (THROUGH HDPE PIPES) WITHIN BATTERY LIMIT AND NEUTRALIZED BEFORE DISCHARGING IT TO STORM WATER SEWER.
  - HARD STAND SHALL BE PROVIDED BY THE PACKAGE CONTRACTOR AS PER ERECTION REQUIREMENT AS SHOWN.
  - SPECIFICATION NO. B269-000-02-42-PCS-0001 FOR SURFACE PREPARATION AND PROTECTIVE COATING & JOB SPECIFICATION NO. B269-000-02-42-PS-0002, FOR EXTERNAL COATING OF BURRIED PIPING & FITTINGS SHALL BE FOLLOWED.
  - ALL CIVIL WORKS INSIDE BATTERY LIMIT ARE UNDER THE SCOPE OF PACKAGE CONTRACTOR.

| REV. | DATE     | REVISIONS                   | BY | CHKD | APPD  | PEMPC |
|------|----------|-----------------------------|----|------|-------|-------|
| B    | 24.09.21 | REVISED & REISSUED FOR BIDS |    | VB   | RA/LP | CD    |
| A    | 15.05.21 | ISSUED FOR BIDS             |    | RSB  | MS    | CD    |



|   |                                      |
|---|--------------------------------------|
| पी-25 परियोजना पानीपत रिफाइनरी                                | P25 PROJECT PANIPAT REFINERY         |
| सौ डब्ल्यू टी पी.1 भवन छत का सामान्य विस्तार प्रवर्धित व्यौरा | SCOPE DRAWING FOR 220 KV GIS PACKAGE |

| SCALE | JOB NO. | UNIT | DIVN. | DEPT. | DWG. NO. | REV. |
|-------|---------|------|-------|-------|----------|------|
| NTS   | B269    | 999  | 81    | 41    | 14561    | B    |

Project: Pre Bid Tie up for 220 kV GIS Package for Panipat Refinery Expansion Project (P25)  
Technical Specification: 220kV GIS with LCC & its Accessories

### Technical Qualifying Requirements & Experience

(11.1.1) The bidder shall be a manufacturer of Gas Insulated Switchboard with SF6 Circuit Breaker of rating 220 kV (minimum) and shall have executed at least One (1) order for EHV indoor, double bus GIS (with single breaker/ one and half breaker/ double breaker execution) of voltage rating 220 kV or above with SF6 circuit breaker having minimum bus rating of 2000 A, 50 kA for 3 sec. and total 5 nos. of circuit breaker bays having same model of EHV GIS and SF6 circuit breaker as being offered, including design, detail engineering, procurement, supply, fabrication, along with either testing and commissioning or supervision of testing and commissioning. The reference job must have been completed and commissioned in the last twelve (12) years and must have completed a period of minimum one (1) year after commissioning as on 31 January 2022.

220 kV Gas Insulated Switchboard shall be supplied from the manufacturer's same unit/ works from which GIS meeting the criteria specified at (11.1.1) above have been supplied for the referenced jobs/ past projects.

### Requisite documents

1. For completion period of at least 1 (one) year after commissioning, any one of the following documents is required to be submitted by the bidder along with the Bid:
  - Certificate for completion of 1 year after commissioning from Client  
OR
  - Certificate of Release of full Security Deposit (Bank Guarantee) by Client against the defect liability period.  
OR
  - Certification by CEO/ CFO with due notarization that Defect Liability Period is completed and there is no claim by client on account of performance of the Plant/Equipment.

  
11/02/2022  
Prepared by

  
11/02/22  
Reviewed by

  
31/20/11  
11/2/22  
Approved by

| Sno    | TITLE   | UOM | QTY    | Remark  |
|--------|---|-----|--------|---|
| 1.0100 | Supply: Unit reference price of GIS part item/ equipment  |     |        | GIS part item/ equipment shall be required for supply as a mandatory spares or any addition/ deletion of equipment, due to damage, theft, additional requirement by customer during detailed engineering or later stage. It is to be ensured by bidder that unit prices have a logical relationship with prices of assemblies in main items (Bay, Busbar etc). The reference prices shall be used for breakup rates, if required at any stage. The reference prices shall be considered for evaluation. |
| 1.0101 | Supply: Unit reference price of GIS part item/ equipment- 220kV , 2000A Circuit Breaker   | Set | 1      | 1 Set= 1 No of single pole with enclosure & without operating mechanism   |
| 1.0102 | Supply: Unit reference price of GIS part item/ equipment- 220kV , 1250A Circuit Breaker   | Set | 1      | 1 Set= 1 No of single pole with enclosure & without operating mechanism   |
| 1.0103 | Supply: Unit reference price of GIS part item/ equipment- 220kV , 2000A Disconnector with Maintenance Earthing Switch   | Set | 1      | 1 Set= 1 No of three pole with enclosure & without operating mechanism  |
| 1.0104 | Supply: Unit reference price of GIS part item/ equipment- 220kV , 2000A Disconnector without Maintenance Earthing Switch  | Set | 1      | 1 Set= 1 No of three pole with enclosure & without operating mechanism  |
| 1.0105 | Supply: Unit reference price of GIS part item/ equipment- 220kV , 2000A Fast acting make proof grounding switch/ High speed make proof grounding switch           | Set | 1      | 1 Set= 1 No of three pole with enclosure & without operating mechanism  |
| 1.0106 | Supply: Unit reference price of GIS part item/ equipment- Surge Arrestor including Surge Counter  | Set | 1      | 1 Set= 1 No of single pole with enclosure   |
| 1.0107 | Supply: Unit reference price of GIS part item/ equipment- Surge Counter   | Set | 1      | 1 Set= 1 No   |
| 1.0108 | Supply: Unit reference price of GIS part item/ equipment- 220kV Current Transformer for Line Bay  | Set | 1      | 1 Set= 4 core of 1 phase CT with enclosure, payable on prorata basis  |
| 1.0109 | Supply: Unit reference price of GIS part item/ equipment- 220kV Current Transformer for Transformer Bay   | Set | 1      | 1 Set= 5 core of 1 phase CT with enclosure, payable on prorata basis  |
| 1.011  | Supply: Unit reference price of GIS part item/ equipment- 220kV Voltage Transformer   | Set | 1      | 1 Set= 3 core of 1 phase PT with enclosure, payable on prorata basis  |
| 1.0111 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism for Circuit Breaker   | Set | 1      | 1 Set= 1 No operating Mechanism suitable for 3 Phase CB   |
| 1.0112 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism for Disconnector with Maintenance earthing switch                                   | Set | 1      | 1 Set= 1 No operating Mechanism suitable for 3 Phase Disconnector with Maintenance earthing switch  |
| 1.0113 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism box for Disconnector without Maintenance earthing switch                            | Set | 1      | 1 Set= 1 No operating Mechanism suitable for 3 Phase Disconnector without Maintenance earthing switch   |
| 1.0114 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism box for Disconnector with Maintenance earthing switch                               | Set | 1      | 1 Set= 1 No operating Mechanism box suitable for 3 Phase Disconnector with Maintenance earthing switch  |
| 1.0115 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism box for Disconnector without Maintenance earthing switch                            | Set | 1      | 1 Set= 1 No operating Mechanism box suitable for 3 Phase Disconnector without Maintenance earthing switch   |
| 1.0116 | Supply: Unit reference price of GIS part item/ equipment- Operating Mechanism for Fast acting make proof grounding switch/ High speed make proof grounding switch | Set | 1      | 1 Set= 1 No operating Mechanism suitable for 3 Phase Fast acting make proof grounding switch/ High speed  |
| 1.0117 | Supply: Unit reference price of GIS part item/ equipment- 220kV, 1 Phase bus bar conductor  | Kg  | 50     | any rating and type   |
| 1.0118 | Supply: Unit reference price of GIS part item/ equipment- 220kV, 1 phase GIS metallic enclosure for bus bar/ any eqjment  | Kg  | 100    | any rating and type   |
| 1.0119 | Supply: Unit reference price of GIS part item/ equipment- Gas permeable/ communication/ barrier type Insulator  | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.012  | Supply: Unit reference price of GIS part item/ equipment- Gas non- permeable/ non- communication/ non-barrier type Insulator                                      | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0121 | Supply: Unit reference price of GIS part item/ equipment- PD sensor   | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0122 | Supply: Unit reference price of GIS part item/ equipment- Pressure/ density monitor monitor device & Switch   | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0123 | Supply: Unit reference price of GIS part item/ equipment- Pressure relief device  | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0124 | Supply: Unit reference price of GIS part item/ equipment- Rupture disc  | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0125 | Supply: Unit reference price of GIS part item/ equipment- Expansion joint   | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0126 | Supply: Unit reference price of GIS part item/ equipment- Flexible connections  | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0127 | Supply: Unit reference price of GIS part item/ equipment- Gas seals   | KG  | 2      | Any type as per requirements  |
| 1.0128 | SPARES- GIS : 220KV, TEE BEND   | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0129 | SPARES- GIS : 220KV, ANGLE BEND (135°)  | Set | 1      | 1 Set= 1 No of any rating and type for single phase (if applicable in design)   |
| 1.013  | SPARES- GIS : 220KV, L-BEND   | Set | 1      | 1 Set= 1 No of any rating and type for single phase   |
| 1.0131 | SERVICES- GIS : 220KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR SUPERVISION OF ERECTION OF GIS  | 10  | MANDAY | Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.   |
| 1.0132 | SERVICES- GIS : 220KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR TESTING & COMMISSIONING OF GIS  | 10  | MANDAY | Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.   |
| 1.0133 | SERVICES- GIS : 220KV, REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - HIRING CHARGES OF HV TEST KIT WITH OPERATOR  | 1   | LOT    | Additional HV test kit charges including charges of operator, HV test kit, accessories & tools required for completion of HV test (Dielectric Test after installation of GIS). This item is executed only if repetition/ additional HV Test is required by BHEL i.e. post successful commissioning of GIS. (if required due to reasons not attributed to the contractor)  |

| Sr |      | Description   | UOM | QTY | Detailed Description of Scope  |
|----|------|---|-----|-----|--|
| 1  | 1.01 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - BUS BARS                              | LOT | 1   | This covers complete GIS System as per technical specification excluding the following BOQ line items.   |
| 2  | 1.02 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - TRANSFORMER GIS BAY MODULE (EXTN.)            | SET | 2   | Extension by addition of transformer feeder bays in existing CG make 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear (one set each on both side). Feeder details similar to Sr. nos. 1 / 2 (Incomer from PR 220kV GIS with Line PT) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)  |
| 3  | 1.03 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - GIS EXTENSION MODULE                  | SET | 2   | Bus extension module for interfacing of transformer feeder bays (of present scope) with existing CG make 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear (one set each on both side). Bidder shall consider the modules including the bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc as applicable.   |
| 4  | 1.04 | SUPPLY- GIS : 220KV, 50KA FOR 3S, OUTDOOR GIS ISOLATING BREAKER BAY   | SET | 2   | Please refer Sr. nos. 1 / 2 (220kV GIS Outdoor IBP with Line PT) of the document: 220 kV ICOG FEEDER DETAIL DATASHEET (HV-100101/HV-100102), Nos: B269-999-16-50-DS-0033. (Excluding SF6 to air bushing/ connection module & Surge Arrester Module , Gas Insulated Bus Duct which are covered in separate BOQ item)  |
| 5  | 1.05 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM- DOUBLE MAIN BUS SCHEME - SF6 TO AIR BUSHING/ CONNECTION         | SET | 6   | Single phase 220kV , 2000A SF6 to Air Bushing for the air termination of the GIS shall be as per IEC.<br>(a) Single phase, 400kV , 2000A , termination module for terminating GIS SF6 bus duct for Potheadyard.<br>(b) Scope of supply shall be as per latest version of IEC .<br>(c) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required.<br>(d) Barrier cones, mechanism box and other items as required.<br>(e) Any other item required to complete the system in all respects but not limited to above.  |
| 6  | 1.06 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - LINE GIS BAY                          | SET | 2   | Incomer from Panipat Refinery 220kV GIS. Please refer Sr. nos. 1 / 2 (Incomer from PR 220kV GIS with Line PT) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)  |
| 7  | 1.07 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - LINE GIS BAY (TYPE 2)                             | SET | 2   | Incomer from Panipat Refinery Isolating Breaker Panel. Please refer Sr. nos. 3 / 4 (Incomer from PR IBP with Line PT) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)  |
| 8  | 1.08 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - BUS COUPLER GIS BAY                               | SET | 2   | Please refer Sr. nos. 5 / 6 (Bus Coupler 1A-2A & Bus Coupler 1B-2B) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034   |
| 9  | 1.09 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - BUS SECTIONALISER BAY MODULE                  | SET | 2   | Please refer Sr. nos. 7 / 8 (Bus Coupler 1A-1B & Bus Coupler 2A-2B) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034   |
| 10 | 1.10 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - BUS MEASUREMENT GIS BAY/ VOLTAGE TRANSFORMER BAY  | SET | 4   | Please refer Sr. nos. 9 / 10 / 11 / 12 (Bus PT 1A, 1B, 2A & 2B) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034   |
| 11 | 1.11 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - TRANSFORMER GIS BAY                   | SET | 6   | Please refer Sr. nos. 13 / 14 / 15 / 16 / 17 / 18 (Transformer Feeder) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)   |
| 12 | 1.12 | SUPPLY- GIS : 220KV, 50KA FOR 3S, GIS DOUBLE MAIN BUS SCHEME - SPARE TRANSFORMER GIS BAY MODULE                     | SET | 2   | Please refer Sr. nos. 19 / 20 (Transformer Feeder Spare) of the document: 220 kV GIS FEEDER DETAIL DATASHEET (HV-100103), Nos: B269-999-16-50-DS-0034. (Excluding Surge Arrester Module which is covered in separate BOQ item)   |
| 13 | 1.13 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM- DOUBLE MAIN BUS SCHEME - SF6 TO EHV CABLE GIS CONNECTION MODULE | SET | 12  | SF6 to EHV cable GIS connection module suitable upto 1600 Sqmm (above 630 Sqmm) and as per technical requirement mentioned in specification, 1 phase Cable, shall be as follows, but not limited to,<br>(a) It shall be of the plug-in type with dry-type or fluid-filled terminations. The interfaces conform to IEC standards. A removable link, which disconnects and isolates the GIS from the cable during high-voltage test for convenience and ease of operations shall also be provided.<br>(b) Termination kit for fixing of cable shall also be provided in line with IEC62271-209.<br>(c) PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, insulators etc. as required.<br>(d) Any other item required to complete the system in all respects but not limited to above. |

| Sr |      | Description   | UOM | QTY | Detailed Description of Scope  |
|----|------|---|-----|-----|--|
| 14 | 1.14 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - SF6 TO EHV CABLE GIS CONNECTION MODULE ( TYPE 2)  | No  | 36  | SF6 to EHV cable GIS connection module suitable upto 630 Sqmm and as per technical requirement mentioned in specification, 1 phase Cable, shall be as follows, but not limited to,<br>(a) It shall be of the plug-in type with dry-type or fluid-filled terminations. The interfaces conform to IEC standards. A removable link, which disconnects and isolates the GIS from the cable during high-voltage test for convenience and ease of operations shall also be provided.<br>(b) Termination kit for fixing of cable shall also be provided in line with IEC62271-209.<br>(c) PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, insulators etc. as required.<br>(d) Any other item required to complete the system in all respects but not limited to above.   |
| 15 | 1.15 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - GAS INSULATED BUS DUCT  | MTR | 30  | GIB length of 1-phase busduct outside the <u>GIS BAY MODULE</u> shall be considered for mode of measurement. This including SF6 Gas, structure, Earthing, foundation bolt, PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, compensator, insulators etc. Complete in all respect.  |
| 16 | 1.16 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - BUS EARTH SWITCH GIS BAY  | SET | 2   | 220kV, 50kA for 3 second, 2000A GIS double main bus scheme bus earth switch bay GIS bay, each set comprising of following but not limited to,<br>(a) 2 set- 1x3 phase high speed make proof grounding switch, complete with operating mechanism.<br>(b) PD sensors, gas monitoring device, pressure relief device, busbar, insulator, expansion joint/ flexible, insulators etc. as required.<br>(c) Any other item required to complete the system in all respects but not limited to above.  |
| 17 | 1.17 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM- DOUBLE MAIN BUS SCHEME - GIS SURGE ARRESTER MODULE WITH SURGE COUNTER   | SET | 48  | 1 Set equals 1 Phase surge arrester. Necessary surge counter for every 3 numbers of surge arrester is inclusive in the scope.  |
| 18 | 1.18 | SUPPLY- GIS : 220KV, LOCAL CONTROL CUBICLE  | No  | 20  | Bidder shall meet the requirement of LCC for the complete GIS System, mode of measurement shall be nos. of Bays with Circuit Breaker. LCC requirements other than Circuit Breaker Bays i.e. Bus PT, Bus earthswitch etc shall be deemed inclusive of bidders scope of respective main item. 2 nos LCC Bay shall be outdoor type.   |
| 19 | 1.19 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION  | LOT | 1   | First filling of SF6 gas for the equipment supplied plus an additional quantity sufficient for conducting all the tests on equipment at site before placing it into successful operation <u>plus 10% extra quantity</u> of first filling as Quality of spare gas.  |
| 20 | 1.20 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM- DOUBLE MAIN BUS SCHEME - STRUCTURE MATERIALS FOR SUPPORT OF GIS, BUS DUCTS, SF6 TO OIL BUSHING/ CONNECTION AND SF6 TO AIR BUSHING/ CONNECTION INCLUDING FOUNDATION BOLTS, EMBEDDED ITEMS, RAILS AND/ OR OTHER ITEMS STRUCTURAL ITEMS REQUIRED | LOT | 1   | Structure Materials for support of GIS, SF6 to oil bushing/ connection and SF6 to air bushing/ connection including Foundation Bolts, Embedded Items, Rails and/ or other items structural items required. All steel structure members shall be hot-dip galvanized after fabrication. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels. In addition to above, supports, platforms, foundation bolts, embedded parts in floors etc., are also included in the scope as per the specification, but not limited to the following,<br>(a) Base Plate, Channel, Metallic / Structural Member for seating of GIS system<br>(b) Lattice / Pipe structure required for GIS bay, GIB, SF6 to oil bushing/ connection and SF6 to air bushing/ connection.<br>(c) Foundation bolt / Anchor Fastening bolts for GIS system, if required.<br>(d) Equipment fixing hardware.<br>(e) Cable tray arrangement (mounted on structures of) GIS bay, GIB, SF6 to oil bushing/ connection and SF6 to air bushing/ connection.<br>(f) Any other structural item required to complete the system in all respects but not limited to above. (Excluding structure for GIB which covered with main GIB item itself) |
| 21 | 1.21 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - EARTHING MATERIALS INCLUDING HIGH FREQUENCY EARTHING, IF APPLICABLE   | LOT | 1   | Earthing Materials, except 40mm MS rod, 75x12mm / 50x6 GI Flat, which shall be provided by BHEL as free issue item (FIM), however, exact requirement shall be intimated by bidder based on the earthing philosophy approved, and Supervision of erection of all earthing connection for GIS to Earth Mesh on Floor shall be scope including any special requirements including high frequency earthing. In case, high frequency earthing is not required, necessary design and calculations shall be submitted by bidder.  |

| Sr |      | Description  | UOM | QTY | Detailed Description of Scope  |
|----|------|--|-----|-----|--|
| 22 | 1.22 | SUPPLY- GIS : 400KV, CONSUMABLES FOR GIS   | LOT | 1   | All consumables including grouting material and chemicals for the chemical anchors bolts etc., if applicable for GIS system shall be provided by bidder, however, in case of consumables with shelf life less than six months shall be supplied with special permission and intimation from BHEL.  |
| 23 | 2.01 | SUPPLY- GIS :ONLINE PARTIAL DISCHARGE (PD) MONITORING SYSTEM FOR BOTH INDOOR & OUTDOOR GIS   | LOT | 1   | 5.7.15.4 Online Partial Discharge(PD) monitoring system for (a) 220kV indoor GIS, (b) 220kV outdoor GIS & (c) 220kV GIS extension. Please refer clause: 5.7.15.4 Online Partial Discharge(PD) monitoring system for both indoor & outdoor GIS of document: B269-999-16-50-SP-0020  |
| 24 | 2.02 | SUPPLY- GIS : ONLINE SF6 GAS FILLING / TOPPING-UP SYSTEM   | SET | 1   | Please refer clause:5.7.15.5 SF6 topping system of document: B269-999-16-50-SP-0020. SF6 topping system shall be provided for 220 kV GIS for filling / topping up SF6 gas to panel under energized condition manually.   |
| 25 | 2.03 | SUPPLY- GIS : PORTABLE PD ANALYZER/ MEASUREMENT KIT SUITABLE FOR GIS ALONG WITH REQUIRED ACCESSORIES                                     | SET | 1   |  |
| 26 | 2.04 | SUPPLY- GIS : SF6 GAS LEAKAGE DETECTOR   | SET | 1   | Please refer clause: 5.7.15.1 SF6 Gas leakage detector of document: B269-999-16-50-SP-0020   |
| 27 | 2.05 | SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS - SF6 GAS FILLING, EVACUATING, FILTERING, DRYING, PUMPING & STORAGE PLANT | SET | 1   | Please refer clause: 5.7.15.2 Gas filling and evacuating plant of document: B269-999-16-50-SP-0020   |
| 28 | 2.06 | SUPPLY- GIS : MANDATORY MAINTENANCE EQUIPMENT SUITABLE FOR GIS - SF6 GAS ANALYZER  | No  | 1   | Please refer clause: 5.7.15.3 SF6 gas analyser of document: B269-999-16-50-SP-0020   |
| 29 | 2.07 | SPARES- GIS : 220KV, MANDATORY SPARES AS PER TECHNICAL SPECIFICATION   | LOT | 1   | Price Break-up are to be submitted with technical bid  |
| 30 | 2.08 | SUPPLY- GIS : RECOMMENDED OPERATION AND MAINTENANCE SPARES   | LOT | 1   | Price Break-up are to be submitted with technical bid  |
| 31 | 3.01 | SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF GIS BAYS INCLUDING LCC   | LOT | 1   | Site service activities shall be carried out at in stages as per requirement or front availability at site, and hence multiple visits for completion of work are envisaged. Site visit for supervision of unloading & verification of materials for proper storage and up-keeping at site includes following activities but not limited to, (a) Supervision of safe unloading of GIS & its accessories at site. (b) Reconciliation, storage & up keeping of materials, with due instructions/ training to site persons for long storage. Supervision of complete GIS System (as per scope of supply) along with all bay Equipments, indoor & outdoor (excluding Bus duct and SF6 to air bushing covered separate BOQ line item) such as and not limited to GIS extension module, GIS bus extension module, surge arrester, voltage transformer, LCC including structure, cabling, earthing & other associated activities shall be included in the scope. (Excluding the Services item covered in separate BOQ items) |
| 32 | 3.02 | SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF GAS INSULATED BUS DUCT   | MTR | 30  | GIB length of 1-phase busduct outside the GIS BAY MODULE shall be considered for mode of measurement.  |
| 33 | 3.03 | SERVICES- GIS : 220KV, SUPERVISION OF ERECTION OF SF6 TO AIR BUSHING   | SET | 6   | Complete in all respect  |
| 34 | 3.04 | SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF GIS  | LOT | 1   | Complete in all respect (excluding Bus duct and SF6 to air bushing covered separate BOQ line item)   |
| 35 | 3.05 | SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF GAS INSULATED BUS DUCT   | MTR | 30  | Complete in all respect  |
| 36 | 3.06 | SERVICES- GIS : 220KV, TESTING & COMMISSIONING OF SF6 TO AIR BUSHING   | SET | 6   | Complete in all respect  |
| 37 | 3.07 | SERVICES- GIS : 400KV, FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR        | LOT | 1   | Complete in all respect  |
| 38 | 3.08 | SERVICES- GIS : INSULATION CO-ORDINATION STUDIES FOR GIS SYSTEM  | LOT | 1   | Complete in all respect  |