

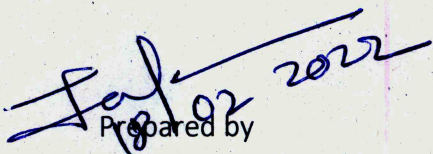
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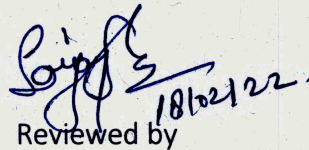
Project: Pre Bid Tie up for 220 kV GIS Package for Panipat Refinery Expansion Project (P25)  
Technical Specification: 220kV GIS with LCC & its Accessories

#### 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.

  
Prepared by

  
Reviewed by

  
Approved by

The Bidder shall provide the documents required for meeting the Technical Qualifying Requirements and Experience as stipulated in the Relevant Sections of the BHEL NIT.

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|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                         |                                                                                                                                                                                                        |          |         |          |                     |               |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|----------|---------------------|---------------|----------|
|                                                                                                                                                                                                                                                       | <h2 style="text-align: center;">BHARAT HEAVY ELECTRICALS LIMITED</h2> <h3 style="text-align: center;">TRANSMISSION PROJECTS ENGINEERING MANAGEMENT</h3> |                                                                                                                                                                                                        |          |         |          |                     |               |          |
|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                         |                                                                                                                                                                                                        |          |         |          |                     |               |          |
|                                                                                                                                                                                                                                                                                                                                        | DOCUMENT No.                                                                                                                                            | TB-PBT-316-PN1                                                                                                                                                                                         | Rev. No. | 03      |          | Prepared            | Checked       | Approved |
|                                                                                                                                                                                                                                                                                                                                        | TYPE OF DOC.                                                                                                                                            | TECHNICAL SPECIFICATION                                                                                                                                                                                |          |         | NAME     | VYOM                | JK            | SKS/AG   |
|                                                                                                                                                                                                                                                                                                                                        | TITLE<br>220kV KV GAS INSULATED SWITCHGEAR                                                                                                              |                                                                                                                                                                                                        |          |         | SIGN     |                     |               |          |
|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                         |                                                                                                                                                                                                        |          |         | DATE     | 15.06.22            | 15.06.22      | 15.06.22 |
|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                         |                                                                                                                                                                                                        |          |         | 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 |          |         |          |                     |               |          |
|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                         |                                                                                                                                                                                                        |          |         |          |                     |               |          |
| <p style="writing-mode: vertical-rl; transform: rotate(180deg);">           COPYRIGHT AND CONFIDENTIALITY<br/>           The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD.<br/>           It must not be used directly or indirectly in anyway detrimental to the interest of the company         </p> | CONTENTS                                                                                                                                                |                                                                                                                                                                                                        |          |         |          |                     |               |          |
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| 4.                                                                                                                                                                                                                                                                                                                                     | SECTION-4:                                                                                                                                              |                                                                                                                                                                                                        |          |         |          | (INCLUDED IN ABOVE) |               |          |
| 5.                                                                                                                                                                                                                                                                                                                                     | TECHNICAL CLARIFICATION NO. 01                                                                                                                          |                                                                                                                                                                                                        |          |         |          | 40                  |               |          |
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|                                                                                                                                                                                                                                                                                                                                        | Rev No.                                                                                                                                                 | Date                                                                                                                                                                                                   | Altered  | Checked | Approved | REVISION DETAILS    |               |          |

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SECTION 1:

SCOPE, PROJECT SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES

## 1. Scope

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

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

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 be followed for system, (please note document with latest revision is to be followed even if the same is placed in different hierarchy)

- o Indian Electricity Act
- o CEA regulations



## 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

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- 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
    - Technical Corrigendum-2
    - Technical Corrigendum-1
    - Section-2 (Original Issued Document)
  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 will address the bidder's listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL of their interpretation. In case bidder fails to convey the same prior to award, BHEL decision on interpretation shall be considered final if need arises during the execution. No additional cost or extra time on account of conflicts/ ambiguities/ deviations shall be admissible.

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

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

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

**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, Panipat Refinery |

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry. In case of revision of document under technical specification, latest revision is to be followed.

## 2. Codes & Standards

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 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                                   |

## 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

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|    |                                                        |          |                                                        |
|----|--------------------------------------------------------|----------|--------------------------------------------------------|
|    | - Input Feeder bay                                     | A        | 2000                                                   |
|    | - Transformer bay                                      | A        | 1250                                                   |
|    | - Bus coupling bay                                     | A        | 2000                                                   |
| 15 | Rated short time withstand current (Symmetrical)       | kA       | 50                                                     |
|    | - Duration                                             | Seconds  | 3                                                      |
| 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    |          | As per IEC on light loaded line and 4 km of cable      |
|    |                                                        |          |                                                        |

**Bidder** to conduct insulation coordination for complete electrical system of MRSS-100 including 66kV GIS. 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 deemed inclusive in the bidder's scope of supply.

**Bidder to please note SLD is indicative only and does not include all items/ components and**



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same shall be finalized during detailed engineering stage meeting tender requirements. Surge arresters are required as per tender. Bidder to refer complete tender including technical amendments and attachments e.g. hardware data sheets of various feeders applicable at 220kV etc.

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.

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. SF6 gas for initial installation of complete GIS System, including wastage during installation, testing and successful commissioning shall be deemed included in the bidder's scope.
2. The offered GIS with LCC & its Accessories shall be complete in all respect in compliance to technical specification and relevant IS / IEC / IEEE standards as applicable. Any other equipment/material required to complete the specified GIS scope of work are inclusive of bidder's scope of supply & services.
3. All essential and desirable accessories are deemed inclusive of offer i.e. and not limited to Gas Monitoring Devices, Pressure Switches, PD sensors, Pressure relief device, insulator, expansion joint/ flexible, bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc. complete in all respect.
4. Total contract value may vary up to  $\pm 30\%$  at contract stage.
5. Any Item not quoted mentioned "Not Applicable" in bid price schedule and found applicable as per technical specification and system requirement shall be supplied free of cost by bidder without any time / cost implication to BHEL / Customer.
6. Length & route of GIB is purely indicative and same shall be finalized during detailed engineering stage.
7. BHEL reserve rights to amend Bay sequence during contract stage, no separate claim shall be admissible in this regards.
8. Supply scope of Testing & Maintenance Equipment – Scope of supply of following Equipments shall be applicable only if covered in BOQ / BPS.
9. SF6 Gas leakage detector
10. Gas filling and evacuating plant: (Gas Processing unit)
11. SF6 gas analyzer

- 
12. Portable Partial Discharge(PD) monitoring system
  13. Online Partial Discharge Monitoring System
  14. Main Bus 1 / 2 / Transfer Bus etc. (as applicable) Gas Insulated Bus Bars running across the length of the switchgear to interconnect each of the bay modules (as per layout) and necessary interfaces (as applicable under the technical requirement) is deemed inclusive in the scope. The same may or may not be indicated with break-up in BOQ / BPS. (BPS means Bid Price Schedule)
  15. 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, **Anchor Bolts**, Foundation Bolts. Hence, the scope shall include supply erection / mounting of hardware.
  16. Power, control & instrumentation cables for Cabling (1.) within GIS, (2.) GIS to LCC, (3.) LCC to LCC shall be deemed inclusive in bidder's scope of supply.
  17. Scope includes for completeness for GIS system with LCC & its Accessories
  18. Cabling between LCC to LCC shall be applicable if required in bidder's design philosophy.
  19. Cables required for bidder supplied GIS sub-system i.e. condition monitoring system (Gas monitoring system, PD monitoring system etc) are to be supplied by bidder as complete system.
  20. Necessary Cable Lug, Glands & shroud etc. required for installation of bidder's supplied cable are deemed inclusive in bidder's scope.
  21. 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.
  22. Power Cable TB's (for both AC & DC incoming feeder cables) shall be suitable for termination of requisite cable.
  23. 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.
  24. 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.
  25. **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.
  26. 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.

27. **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.
28. 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.
29. Bidder to submit price break-up of spares as per Annexure\_Sapres (B269-999-16-50-SL-0020) FOR GIS during tender stage. It shall not be binding on the BHEL to procure all of these mandatory spares.
30. ~~Length of GIB is purely indicative and same shall be finalized during detailed engineering stage in line with final approval of drawings from IOCL.~~
31. 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.
32. Any other equipment/material required to complete the specified GIS scope of work are inclusive of bidder's scope of supply.
33. ~~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.
34. 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.
35. Any change in bay pitch (distance between bays): In a case where shifting of GIS bays shall be called by BHEL (during contract stage) due to layout requirement / cost optimization / revision / change in civil architectural requirement (Refer drawing B26900081410240B, SUBSTATION-100 (MAIN RECEIVING SUBSTATION) or due to expansion joint requirement in the GIS building, Bidder to incorporate the same with full compliance of technical requirement. ~~Payment equivalent of BPS / BOQ item under head "Gas Insulated Bus Duct" shall be operated for additional length of Main Bus, subject to such shifting is not attributed to bidder.~~
36. 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

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 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.

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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 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.

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## 6. Earthing of GIS

1. Bidder to submit detailed calculations and layout drawings for earthing system during detailed engineering stage based on technical specification, bidder's design philosophy, IS/IEC/IEEE requirement as applicable. Bidder to provide the bill of quantity of entire GIS system with LCC & its Accessories
2. Supply of 40 mm MS ROD, 75X12 mm GI Flat, 50X06 mm GI Flat is not in bidder's scope of supply.
3. All other earthing materials including complete Hardwares, nut, bolts washers, lug etc. required, as per earthing design shall be in bidder's scope of supply.
4. Installation / Erection of earthing will be done by BHEL team under the supervision of bidder/manufacture, as per manufacturer's design.

## 7. Modular Design & Future extensions

5. 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.
6. The GIS shall be of either single-phase enclosure type or three-phase enclosure type for voltage levels of 220kV.
7. In those design where bus bar is continuous, provision is to be made available for isolation of individual bay without disturbing adjacent bay.
8. 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.
9. 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.
10. 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.
11. 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.
12. Where bus Coupler is specified and in case of any internal arc fault in a busbar, busbar



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- disconnecter 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.
13. 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.
  14. Each bay module should be equipped with suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.
  15. Material clearance certificate shall be issued after demonstration of the functionality of maintenance equipment.
  16. Structural Steel, Support Structure & Hardwares (required for installation of complete GIS system with LCC & its Accessories etc.) are deemed inclusive of bidder's scope of supply. The same may or may not be indicated with break-up in BOQ / BPS.
  17. All steel structure members shall be hot-dip galvanized after fabrication (excluding floor embedded items for which standard practice is to be followed). All field assembly joints shall be bolted. Field welding shall generally not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work.
  18. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter.
  19. Lattice / Pipe structure Materials for support of GIS, Bus Ducts, SF6 to oil bushing/ SF6 to cable connection and SF6 to air bushing/ connection including Anchor Fastener Bolts, Foundation Bolts, Base Plate / Channel / Metallic / Structural Member for seating of GIS system, all floor and wall Embedded Items, wall crossing arrangements, Rails and/ or other items structural items as required. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, Anchor Fasteners, foundation bolts, nuts and washers, equipment fixing hardware shall be provided to fasten the switchgear base frames to the foundation channels as applicable
  20. 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.
  21. Structural steel for complete GIS system with LCC & its Accessories is deemed inclusive in bidder's scope of supply.

## 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 disconnecter 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

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)                                    |

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|----|----------------------------------------------------------------------------------------------------------------------------------------------|
| 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

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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

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be included in bidder's scope.

### 13. Inspection & Testing

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

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

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 |

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|        |                                                 |
|--------|-------------------------------------------------|
| 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            |
| 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.



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## 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)

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

1. Any scope of supply / services mentioned in Section-2 or Section-3 of technical specification but not having any relationship with GIS, LCC & its Accessories and not covered in Section-1 or BPS / BOQ shall be deemed excluded from bidder's scope. In case of ambiguity bidder to submit the same with technical bid / schedule of technical deviations.
2. 66 kV (& below) GIS system is not in bidder's scope, irrespective of the specification for the same may appear in technical specification.
3. Outdoor AIS Equipments, Air Insulated Bus Duct.
4. 220 kV Cables shall be supplied and laid by others.
5. 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, necessary interfacing supply services are in bidder's scope.
6. Installation / Erection of GIS with LCC & its Accessories except supervision work.
7. Cable laying & terminations, however supervision work & termination of special cables shall be in bidder's scope.
8. Open & Closed stores at site. (Bidder to provide space requirement in tech bid)
9. Local transportation/ conveyance for bidder's engineers shall be arranged by BHEL between local stay and site.
10. Office assistance shall be provided BHEL including sitting facility etc.
11. Receipt & unloading of material at site except supervision work
12. Terminal connector for SF6 to Air Bushing to conductor or any other interfacing equipment.
13. Watch & Ward of GIS material at BHEL Store

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14. Civil Works i.e. GIS Hall, civil works requirement for GIS System. (Please refer clause "Structure-Steel" for bidder's scope of supply)
  15. EOT crane, Air Conditioning & Ventilation System, Illumination System & Fire Protection System, Fire detection & alarm system, however complete input shall be provided for EOT and other system
  16. Control Relay & Protection Panels, Numerical Relays, Bus Bar Protection Panel, SAS & ECS system, AC Distribution Board, DC Distribution Board, Battery, Charger, UPS
  17. Earthing material i.e. 40 mm MS Rod, 50X6 GI Flat, 75X12 GI Flat, 100X12 GI Flat for earthing
  18. Power & Control cable beyond LCC
  19. BHEL / Customer / BHEL appointed 3rd party inspector travel, lodging & boarding charges during testing / inspection.
  20. Transformer / Reactor
  21. Plant Communication
  22. Solar photovoltaic system
  23. Fire Proof Sealing System

| Sr       | Description                                                                                                            | UOM | QTY<br>Rev.1 | Detailed Description of Scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|------------------------------------------------------------------------------------------------------------------------|-----|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | <b>SUPPLY- GIS : GAS INSULATED SWITCHGEAR (GIS) AS PER TS</b>                                                          |     |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1.01     | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM - DOUBLE MAIN BUS SCHEME - BUS BARS                                 | LOT | 1            | Please refer revised Bay numbers. This covers complete GIS System under this technical specification (TB-PBT-316-PN1) excluding the following BOQ line items. In the event of changes in present scope, payment shall be made on pro-rata basis of number of circuit breaker bays.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1.02     | 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, Rev.D . (Excluding Surge Arrester Module & Line PT Module which are covered in separate BOQ item)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 1.03     | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - LINE GIS BAY (TYPE 2)                                | SET | 2            | Incomer from Panipat Refinery <del>Isolating Breaker Panel</del> . 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, Rev.D . (Excluding Surge Arrester Module & Line PT Module which are covered in separate BOQ item)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1.04     | 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, Rev.D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.05     | 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, Rev.D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1.06     | SUPPLY- GIS : 220KV, 50KA FOR 3S, 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, Rev.D Complete including Isolator & Bus earth switch.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1.07     | SUPPLY- GIS : 220KV, 50KA FOR 3S, 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, Rev.D . (Excluding Surge Arrester Module which is covered in separate BOQ item)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1.08     | 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, Rev.D . (Excluding Surge Arrester Module which is covered in separate BOQ item)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1.09     | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, GIS DOUBLE MAIN BUS SCHEME - SF6 TO EHV CABLE GIS CONNECTION MODULE ( TYPE 2) | SET | 42           | 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.<br>(e) 1 Set equals to supplies required for one Phase |

| Sr   | Description                                                                                                                                                                                                                        | UOM | QTY<br>Rev.1 | Detailed Description of Scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 1.10 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM-DOUBLE MAIN BUS SCHEME - GIS SURGE ARRESTER MODULE WITH SURGE COUNTER                                                                                                           | SET | 42           | 1 Set equals 1 Phase surge arrestor. Necessary surge counter for every 3 numbers of surge arrestor is inclusive in the scope.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1.11 | SUPPLY- GIS : 220KV, LOCAL CONTROL CUBICLE                                                                                                                                                                                         | SET | 16           | 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 supply with respective main item.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1.12 | SUPPLY- GIS : 220KV, 50KA FOR 3S, 2000A, DOUBLE MAIN BUS SCHEME - SF6 GAS REQUIRED FOR PLACING GIS INTO SUCCESSFUL OPERATION                                                                                                       | LOT | 1            | (1.) First filling of SF6 gas for the equipment supplied plus (2.) an additional quantity sufficient for conducting all the tests on equipment at site before placing it into successful operation plus (3.) 10% extra quantity of first filling as Quality of spare gas. (4.) In the event of changes in present scope, payment shall be made on pro-rata basis of number of circuit breaker bays.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1.13 | SUPPLY- GIS : 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)<br>(g) In the event of changes in present scope, payment shall be made on pro-rata basis of number of circuit breaker bays. |
| 1.14 | SUPPLY- GIS : EARTHING MATERIALS INCLUDING HIGH FREQUENCY EARTHING, IF APPLICABLE                                                                                                                                                  | LOT | 1            | Earthing Materials, except 40mm MS rod,75x12mm / 50x6 / 100X12 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. In the event of changes in present scope, payment shall be made on pro-rata basis of number of circuit breaker bays.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1.15 | SUPPLY- GIS : 220KV, 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Sr                                                              | Description                                                                                                                                              | UOM | QTY<br>Rev.1 | Detailed Description of Scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| 1.16                                                            | SUPPLY- GIS : 220KV, MAIN ITEM - LINE PT MODULE                                                                                                          | SET | 18           | 1 Set equals 1 Phase of line PT module complete in all respect. Please note, this shall be part of main bay & separate BOQ item is created for billing break-up purpose.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1.17                                                            | SUPPLY- GIS : CONTROLLED SWITCHING DEVICE (CSD)                                                                                                          | Set | 8            | CSD: controlled switching device/synchronous switching device in each of the 220kV outgoing transformer feeders (including at all spare feeders) at 220kV GIS substation (MRSS-100) to limit voltage dip during closing of transformer incomer breaker. Bidder to carry out transformer inrush current study for all EHV transformer under various operating conditions including charging through existing CPP SS-28 interconnected with SS-64.                                                                                                                                                                                                                                                                                               |
| <b>2 SPARES- GIS : GAS INSULATED SWITCHGEAR (GIS) AS PER TS</b> |                                                                                                                                                          |     |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2.01                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - CONTINUOUS ONLINE PARTIAL DISCHARGE (PD) MONITORING SYSTEM                                                 | LOT | 1            | Bidder to provide <u>CONTINUOUS ONLINE PARTIAL DISCHARGE (PD) MONITORING SYSTEM</u> . Please refer clause: 5.7.15.4 Online Partial Discharge(PD) monitoring system for (a) 220kV indoor GIS, (b) <del>220kV outdoor GIS &amp; (c)- 220kV GIS extension</del> . Please refer clause: 5.7.15.4 Online Partial Discharge(PD) monitoring system for <del>both</del> 220kV indoor & <del>outdoor</del> GIS of document: B269-999-16-50-SP-0020. Following online PD monitoring system shall be provided: (1.) Online PD monitoring system for offered GIS. (2.) <del>One PD monitoring system at Outdoor Switchyard substation</del> (3.) <del>Modification/Integration of existing PD monitoring system to include 2 nos. GIS bay extension.</del> |
| 2.02                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - 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. (Remark: 1 Set for each location i.e. separate set for MRSS-100 (i.e. common set for 220kV existing & 66kV Indoor future GIS) <del>&amp; New gantry substation (i.e. common set for 220kV Outdoor existing GIS and 33kV indoor future GIS).</del>                                                                                                                                                                                                                                                                       |
| 2.03                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - PORTABLE PD (PARTIAL DISCHARGE) ANALYZER/ MEASUREMENT KIT SUITABLE FOR GIS ALONG WITH REQUIRED ACCESSORIES | SET | 1            | (Remark: 1 Set of each item for each location i.e. separate set for MRSS-100 (Remark: 1 Set for each location i.e. separate set for MRSS-100 (i.e. common set for 220kV existing <del>&amp; 66kV Indoor future GIS</del> ) <del>&amp; New gantry substation (i.e. common set for 220kV Outdoor existing GIS and 33kV indoor future GIS).</del>                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2.04                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - 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. (Remark: 1 Set for each location i.e. separate set for MRSS-100 (i.e. common set for 220kV existing & 66kV Indoor future GIS) <del>&amp; New gantry substation (i.e. common set for 220kV Outdoor existing GIS and 33kV indoor future GIS).</del>                                                                                                                                                                                                                                                                                                                                                                                                  |
| 2.05                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - 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. (Remark: 1 Set for each location i.e. separate set for MRSS-100 (i.e. common set for 220kV existing & 66kV Indoor future GIS) <del>&amp; New gantry substation (i.e. common set for 220kV Outdoor existing GIS and 33kV indoor future GIS).</del>                                                                                                                                                                                                                                                                                                                                                                                          |
| 2.06                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - SF6 GAS ANALYZER                                                                                           | SET | 1            | Please refer clause: 5.7.15.3 SF6 gas analyser of document: B269-999-16-50-SP-0020. (Remark: 1 Set for each location i.e. separate set for MRSS-100 (i.e. common set for 220kV existing & 66kV Indoor future GIS) <del>&amp; New gantry substation (i.e. common set for 220kV Outdoor existing GIS and 33kV indoor future GIS).</del>                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2.07                                                            | SUPPLY- GIS MANDATORY MAINTENANCE EQUIPMENT - SF6 Gas Handling Unit / Service Cart                                                                       | SET | 1            | Please refer clause: 6.11 of document: 6-51-0066, Document title: SPECIFICATION FOR EXTRA HIGH VOLTAGE GAS INSULATED SWITCHGEAR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Sr                                                                | Description                                                                                                                       | UOM | QTY<br>Rev.1 | Detailed Description of Scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| 2.08                                                              | SPARES- GIS : 220KV, MANDATORY SPARES AS PER TECHNICAL SPECIFICATION                                                              | LOT | 1            | Please refer Clause 6.1 of Engineering Design Basis (Electrical), B269-999-16-50-EDB-1001 inclusive of the followings. (2.1 is covered in separate BOQ item)<br>2.2 Handle for disconnect switch drive 4 Nos.<br>2.3 Handle for earthing switch drive 4 Nos.<br>2.4 Pre selection key for three position switch 1 No.<br>2.5 Power cable termination kit 2 sets<br>2.6 Tripping coil 2 No.<br>2.7 Closing coil 2 No.<br>2.8 Capacitive type voltage detectors 1 Set<br>2.9 Control fuses / MCB 10 Nos. of each rating & type<br>2.10 Density monitoring device 2 Nos of each type<br>2.11 Pressure Gauge 2 Nos of each type<br>2.12 Indicating lamps covers 5 nos. of each colour<br>2.13 Indicating lamps 20% or 3 nos. (min.), whichever is more                                                                                                                                                                                                                                                                   |
| 2.09                                                              | SUPPLY- GIS : PORTABLE GAS FILLING EQUIPMENT / SF6 GAS CART                                                                       | SET | 1            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>3 SERVICES- GIS : GAS INSULATED SWITCHGEAR (GIS) AS PER TS</b> |                                                                                                                                   |     |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 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, TESTING & COMMISSIONING OF GIS                                                                             | LOT | 1            | Complete in all respect (excluding Bus duct and SF6 to air bushing covered separate BOQ line item)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 3.03                                                              | SERVICES- GIS : 220KV, FINAL SUCCESSFUL HV/ POWER FREQUENCY TESTING OF GIS INCLUDING ARRANGING OF HV TEST KIT ALONG WITH OPERATOR | LOT | 1            | Complete in all respect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3.04                                                              | SERVICES- GIS : INSULATION CO-ORDINATION & VFT STUDIES FOR GIS SYSTEM                                                             | LOT | 1            | Complete in all respect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



| Sr   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                  | UOM | QTY<br>Rev.1 | Detailed Description of Scope                         |
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| 4    | <b>SPARES- GIS : REFERENCE UNIT PRICE FOR ADDITION / DELETION OF SUPPLY ITEMS</b><br>(Unit Prices of Individual Equipment included here or in mandatory spares are required for any Addition/Deletion of Equipment and replacement of damaged items. Vendor to ensure that the unit prices have a logical relationship with prices of assemblies in main items. Quoting for unit prices is mandatory and shall be considered for evaluation) |     |              |                                                       |
| 4.01 | SPARES- GIS : SINGLE PHASE BUS BAR WITHOUT ENCLOUSER                                                                                                                                                                                                                                                                                                                                                                                         | MTR | 1            | Complete in all respect.                              |
| 4.02 | SPARES- GIS : GIS METALLIC ENCLOSURE                                                                                                                                                                                                                                                                                                                                                                                                         | KG  | 50           |                                                       |
| 4.03 | SPARES- GIS : EXPANSION BELLOWS/ JOINTS                                                                                                                                                                                                                                                                                                                                                                                                      | Set | 1            | For Single Phase of any type and any rating.          |
| 4.04 | SPARES- GIS : TEE BEND                                                                                                                                                                                                                                                                                                                                                                                                                       | Set | 1            | For Single Phase of any type and any rating.          |
| 4.05 | SPARES- GIS : L-BEND                                                                                                                                                                                                                                                                                                                                                                                                                         | Set | 1            | For Single Phase of any type and any rating.          |
| 4.06 | 220KV GIS- SINGLE PHASE AND SINGLE CORE OF CURRENT TRANSFORMER EXCLUDING ASSOCIATED ENCLOSURE AND PRIMARY CONDUCTOR                                                                                                                                                                                                                                                                                                                          | SET | 1            | For Single Phase and core of any type and any rating. |
| 4.07 | SPARES- GIS : TRIP COIL ASSEMBLY WITH RESISTOR FOR GIS CIRCUIT BREAKER (AS APPLICABLE)                                                                                                                                                                                                                                                                                                                                                       | SET | 3            |                                                       |
| 4.08 | SPARES- GIS : CLOSING COIL ASSEMBLY WITH RESISTOR FOR GIS CIRCUIT BREAKER (AS APPLICABLE)                                                                                                                                                                                                                                                                                                                                                    | SET | 3            |                                                       |
| 4.09 | SPARES- GIS : RELAYS, POWER CONTACTORS, PUSH BUTTONS, TIMERS & MCBS ETC. (AS APPLICABLE) OF EACH TYPE FOR GIS CIRCUIT BREAKER                                                                                                                                                                                                                                                                                                                | SET | 1            |                                                       |
| 4.10 | SPARES- GIS : SINGLE PHASE DISCONNECTOR SWITCH INCLUDING MAINCIRCUIT, ENCLOSURE AND SUPPORT INSULATOR ETC., COMPLETE IN ALL RESPECT                                                                                                                                                                                                                                                                                                          | SET | 1            |                                                       |
| 4.11 | SPARES- GIS : SINGLE PHASE MAINTENANCE EARTHING SWITCH INCLUDING MAINCIRCUIT, ENCLOSURE AND SUPPORT INSULATOR ETC., COMPLETE IN ALL RESPECT                                                                                                                                                                                                                                                                                                  | SET | 1            |                                                       |
| 4.12 | SPARES- GIS : SINGLE PHASE FAST EARTHING SWITCH INCLUDING MAIN CIRCUIT, ENCLOSURE AND SUPPORT INSULATOR ETC., COMPLETE IN ALL RESPECT                                                                                                                                                                                                                                                                                                        | SET | 1            |                                                       |
| 4.13 | SPARES- GIS : DRIVE MECHANISM BOX FOR GIS CIRCUIT BREAKER                                                                                                                                                                                                                                                                                                                                                                                    | SET | 1            |                                                       |
| 4.14 | SPARES- GIS : DRIVE MECHANISM BOX FOR GIS DISCONNECTOR SWITCH                                                                                                                                                                                                                                                                                                                                                                                | SET | 1            |                                                       |
| 4.15 | SPARES- GIS : DRIVE MECHANISM BOX FOR GIS MAINTENANCE EARTH SWITCH                                                                                                                                                                                                                                                                                                                                                                           | SET | 1            |                                                       |
| 4.16 | SPARES- GIS : DRIVE MECHANISM BOX FOR GIS FAST EARTHING SWITCH                                                                                                                                                                                                                                                                                                                                                                               | SET | 1            |                                                       |

| Sr   | Description                                                                                                                                                                                                                                                                                                                                                                                                               | UOM    | QTY<br>Rev.1 | Detailed Description of Scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| 4.17 | SPARES- GIS : GIS-SF6 GAS                                                                                                                                                                                                                                                                                                                                                                                                 | Kg     | 50           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.18 | SPARES- GIS : 220KV, 50KA FOR 3S, 2000A, MAIN ITEM-DOUBLE MAIN BUS SCHEME - SF6 TO EHV CABLE GIS CONNECTION MODULE                                                                                                                                                                                                                                                                                                        | SET    | 1            | 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.<br>(e) 1 Set equals to supplies required for one Phase |
| 5    | <b>SERVICES- GIS : REFERENCE UNIT PRICE FOR ADDITION / DELETION OF SERVICES</b><br><b>(Unit Prices of Individual services included here are required for any Addition/Deletion of Equipment and replacement of damaged items. Vendor to ensure that the unit prices have a logical relationship with prices of assemblies in main items. Quoting for unit prices is mandatory and shall be considered for evaluation)</b> |        |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5.01 | SERVICES- GIS : REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR SUPERVISION OF ERECTION OF GIS                                                                                                                                                                                                                                                                                                           | MANDAY | 10           | Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 5.02 | SERVICES- GIS : REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - SERVICES FOR TESTING & COMMISSIONING OF GIS                                                                                                                                                                                                                                                                                                           | MANDAY | 10           | Charges for repetition of services - (if required due to reasons not attributed to the contractor) This item will be executed only if repetition of services is required by BHEL.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 5.03 | SERVICES- GIS : REF. UNIT PRICE OF GIS INDIVIDUAL ITEM/ EQUIPMENT - HIRING CHARGES OF HV TEST KIT WITH OPERATOR                                                                                                                                                                                                                                                                                                           | LOT    | 1            | Additional HV test kit charges including charges of operator, HV test kit, accessories & tools required for completion of HV test (Dielectric Test after installation of GIS). This item is executed only if repetition/ additional HV Test is required by BHEL i.e. post successful commissioning of GIS. (if required due to reasons not attributed to the contractor)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5.04 | SERVICES- GIS : TRAINING FOR GIS AT SITE                                                                                                                                                                                                                                                                                                                                                                                  | DAY    | 6            | Training for TEN number OWNER' s Engineers at Site for GIS with LCC & its Accessories including Partial Discharge Monitoring system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 5.05 | SERVICES- GIS : TRAINING FOR GIS AT MANUFACTURER WORKS                                                                                                                                                                                                                                                                                                                                                                    | DAY    | 1            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

**TECHNICAL AMENDMENT NO: 02 (ELECTRICAL)**  
**TO**  
**TENDER: B269-999-16-50-EB-T-0020FOR 220KV GIS PACKAGE**

**(PROJECT: P-25, M/s IOCL-PANIPAT)**

**Bidder to please read this documents for scope of supply & services for 220kV GIS System and all associated equipment, sub-system etc. Other portion of document please be considered for reference only. Please refer Section-1 of Technical Specification clause 20 for items and services Exclusions from Bidder's scope (NOT in bidder's scope)**

**Please read contractor means bidder for GIS scope**

|          |                                 |     |         |          |
|----------|---------------------------------|-----|---------|----------|
| 19.05.22 | Issued as Technical Amendment-2 | MKM | RG      | HK       |
| DATE     | PURPOSE                         | BY  | CHECKED | APPROVED |

**SUBJECT** : **Technical Amendment No.: 02**  
**TENDER NO.** : **B269-999-16-50-EB-T-0020**

The terms, conditions and specifications of Bidding Document stand modified to the extent indicated under column "MODIFICATIONS/ADDITION/DELETION". Corresponding implications of the same, else-where in the bid package shall be taken care appropriately. All other terms & conditions, stipulations and specifications of Bidding Document shall remain unaltered.

| S.No | Section No./ Document No.    | Clause No./ Item No. | Subject                           | Modifications / Additions/Deletions/ Clarification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------|------------------------------|----------------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | B269-999-16-50-SP-0020 Rev.D | Complete Document    | Scope of Work & Job Specification | <b>Modification:</b><br>Scope of work & Job Specification (Electrical) for 220kV GIS Package (B269-999-16-50-SP-0020 Rev.D) has been replaced by Scope of work & Job Specification (Electrical) for 220kV GIS Package (B269-999-16-50-SP-0020 Rev.E). Copy enclosed herewith.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 2.   | B269-999-16-50-SL-0020 Rev.E | Complete Document    | Mandatory Spare List              | <b>Modification:</b><br>Mandatory spare list-Electrical (B269-999-16-50-SL-0020 Rev.E) has been replaced by next revision (B269-999-16-50-SL-0020 Rev.F). Copy enclosed herewith.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3.   | Table of Contents            |                      | Data sheet (Electrical)           | <b>Deletion:</b><br>Work related with 220kV incoming gantry in 95x95 m area including associated 220kV outdoor GIS bays, 220/33 kV transformers, 33kV GIS isolation breaker panels, substation and metering room stands deleted.<br><br>Accordingly, following data sheets stands deleted:<br>a. Feeder details for 220kV Outdoor GIS IBP (B269-999-16-50-DS-0033 Rev.B)<br>b. Hardware datasheet- 220kV GIS- Outdoor Isolating Breaker Panel (B269-999-16-50-S-0037 Rev.B)<br>c. Datasheet for outdoor switchyard (B269-999-16-50-DS-0055 Rev.B)<br>d. Datasheet for EHV Isolator (B269-999-16-50-DS-0056 Rev.B)<br>e. Datasheet for Outdoor EHV current & voltage transformer (B269-999-16-50-DS-0057 Rev.B)<br>f. Datasheet for Lighting Arrester (B269-999-16-50-DS-0058 Rev.A)<br>g. Datasheet for insulators busbar material & earthing system (B269-999-16-50-DS-0059 Rev.A)<br>h. Datasheet for 33kV isolating breaker panel (B269-999-16-50-DS-0071 Rev.C)<br>i. Hardware datasheet- 33kV isolating breaker panel (B269-999-16-50-DS-0073 Rev. B)<br>j. Datasheet for 220/33kV Power Transformer (B269-999-16-50-DS-0306 Rev.B)<br>k. SAS for new gantry substation (B269-999-16-50-DS-0131 Rev.A) |

|     |                                         |                                  |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|-----------------------------------------|----------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.  | B269-999-16-50-DS-0054 Rev.B            | Complete Datasheet               | ECS IO List for 220kV GIS Package         | <b>Modification:</b><br>ECS IO List for 220kV GIS Package (B269-999-16-50-DS-0054 Rev.B) has been replaced by B269-999-16-50-DS-0054 Rev.C. Copy enclosed herewith.                                                                                                                                                                                                                                                                                                |
| 5.  | B269-999-16-50-DS-0034 Rev.D            | Complete Datasheet               | 220kV Feeder details datasheet            | <b>Modification:</b><br>220kV Feeder details datasheet (B269-999-16-50-DS-0034 Rev.D) is replaced by B269-999-16-50-DS-0034 Rev.E. Copy enclosed herewith.                                                                                                                                                                                                                                                                                                         |
| 6.  | <del>B269-999-16-50-DS-0034 Rev.E</del> | <del>Complete Datasheet</del>    | <del>66kV Feeder details datasheet</del>  | <del><b>Modification:</b><br/>66kV Feeder details datasheet (B269-999-16-50-DS-0035 Rev.D) is replaced by B269-999-16-50-DS-0035 Rev.E. Copy enclosed herewith.</del>                                                                                                                                                                                                                                                                                              |
| 7.  | B269-999-16-50-00200 Rev.D              | Complete Document                | Key SLD                                   | <b>Modification:</b><br>Key Single Line Diagram (B269-999-16-50-00200 Rev.D) has been replaced by B269-999-16-50-00200 Rev.E. Copy enclosed herewith.                                                                                                                                                                                                                                                                                                              |
| 8.  | TABLE OF CONTENTS                       |                                  | Standard specification                    | <b>Deletion:</b><br>Following EIL standard specification has been deleted:<br>a. Specification for outdoor EHV isolators and earthing switches (6-51-0009 Rev.5)<br>b. Specification for outdoor EHV current and voltage transformers (6-51-0011 Rev.5)<br>c. Specification for High Voltage gas insulated switchgear (6-51-0065 Rev.1)<br>d. Specification for outdoor switchyard (6-51-0085 Rev.4)<br>e. Specification for lightning arrestors (6-51-0096 Rev.6) |
| 9.  | TABLE OF CONTENTS                       |                                  | Inspection Test Plan                      | <b>Deletion:</b><br>Following inspection test plan have been deleted:<br>a. Inspection and test plan for outdoor EHV isolators and earthing switches (6-81-1009 Rev.3)<br>b. Inspection and test plan for outdoor EHV current transformers and voltage transformers (6-81-1011 Rev.3)<br>c. Inspection & test plan for lightning arrestors (6-81-1096 Rev.3)                                                                                                       |
| 10. | TABLE OF CONTENT                        |                                  | General Notes                             | <b>Addition:</b><br>Following documents have been added:<br>a. General notes for cabling system (B269-999-16-50-4100 Rev.0)<br>b. General notes for lighting system (B269-999-16-50-4200 Rev.0)<br>c. General notes for earthing & lightning protection system (B269-999-16-50-4300 Rev.0)                                                                                                                                                                         |
| 11. | B269-999-16-50-EDB-1001 Rev.0           | 5.3.3, Page No. 15 of 49         | Utilisation Voltage for critical supplies | <b>Deletion:</b><br>Contractor to ignore the reference of 'Note-1' & 'Note-2' in Sl. No. 1 & 2 of Table in cl. no. 5.3.3                                                                                                                                                                                                                                                                                                                                           |
| 12. | B269-999-16-50-EDB-1001 Rev.0           | 5.6.4 (Note no. 6) Page 31 of 49 | Cable termination box                     | <b>Modification:</b><br>6. 220kV side cable terminal box for EHV power transformer i.e. 220/66kV shall be oil filled type only. 66kV side cable terminal box for 66/6.9kV power transformer shall be air insulated phase segregated type.                                                                                                                                                                                                                          |

|     |                               |                                                    |                                              |                                                                                                                                                                                                                                                                                                                                            |
|-----|-------------------------------|----------------------------------------------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13. | B269-999-16-50-EDB-1001 Rev.0 | 5.6.4 (Note-2)<br>Page 31 of 49                    | Power Transformer                            | <b>Modification:</b><br>Note-2: EHV transformer with 220kV primary shall be provide with both NIFPS & HVWS based fire fighting system. For all other power transformers rated above 5MVA or with oil quantity greater than 2000 ltrs, HVWS based fire fighting system shall be provided. Deluge valve shall be provided under canopy/shed. |
| 14. | B269-999-16-50-EDB-1001 Rev.0 | Cl. no. 5.6.14,<br>Note-6 & cl. no. 5.6.11, Note-8 | Online battery bank monitoring system        | <b>Modification:</b><br>Online battery health monitoring system shall have the provision of cell voltage measurement. Measurement of cell temperature & cell impedance is not required.                                                                                                                                                    |
| 15. | Annexure-A attached with TA-1 | Sl. No. 6 & 8                                      | Fire Alarm System, PLCC System               | <b>Deletion:</b><br>Sl. no. 6 (details of existing fire alarm system) & sl. no. 8 (details of PLCC system) are not applicable & stands deleted.                                                                                                                                                                                            |
| 16. | Annexure-A attached with TA-1 | Sl. no. 16 (g)                                     | Location of gantry substation, SS-28 & SS-63 | <b>Modification:</b><br>Location of new gantry substation in (95x95) mtr. area along with SS-28, SS-63 (shown in layout) are not applicable & stands deleted.                                                                                                                                                                              |

(SIGNATURE AND STAMP OF BIDDER)

# 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

**Bidder to please read this documents for scope of supply & services for 220kV GIS System and all associated equipment, sub-system etc. Other portion of document please be considered for reference only. Please refer Section-1 of Technical Specification clause 20 for items and services Exclusions from Bidder's scope (NOT in bidder's scope)**

**Please read contractor means bidder for GIS scope**

|         |            |                                  |             |            |             |
|---------|------------|----------------------------------|-------------|------------|-------------|
| E       | 19.05.2022 | REVISED & REISSUED WITH TA-2     | MKM         | RG         | HK          |
| D       | 11.04.2022 | REVISED AND REISSUED WITH TA-01  | MKM         | RG         | HK          |
| C       | 27.09.2021 | REVISED AND REISSUED 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 P-25 project in IOCL Panipat Refinery, power shall be received at MRSS-100 at 220kV level from owner's existing 220kV substation, SS-64 through 4 nos. 220kV GIS bays. Existing two (2) nos. 220kV outgoing spare GIS bays available in CG

make 220kV GIS of SS-64 shall be utilised. In addition to that, 2 nos. 220kV GIS bays shall be added with existing CG make 220kV GIS. Each of these four (4) nos. GIS bays shall be suitable to evacuate 200MVA power to downstream substation, MRSS-100. Suitable modification shall be done by contractor through GIS OEM in existing 2 nos. 220kV spare GIS bays to accommodate owner's 220kV cable termination. .

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. MRSS-100 shall also include 2 nos. 66/6.9kV power transformers & 4 nos. 6.6/0.433kV distribution transformers to feed internal loads of MRSS-100 by contractor as well as to feed external loads by owner.

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 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 bus coupler & one dummy bus coupler) 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, bus coupler 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 bus coupler. 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.

### **3 SCOPE OF WORK (ELECTRICAL)**

#### **3.1 GENERAL**

The electrical scope of work under this tender shall include but not be limited to basic and detailed engineering, manufacturing, supply, transportation to site, storage at site, inspection at manufacturer's work, erection, testing, commissioning of all equipments, supply of all mandatory spares, commissioning spares, special tools and tackles, cabling, earthing, lighting, fire alarm, plant communication works as defined in the scope document, drawings, installation standards, equipment datasheets, standard specifications, etc. attached or referred with the tender document.

#### **3.2 SCOPE OF BASIC AND DETAILED ENGINEERING**

The scope of basic and detailed engineering includes sizing and selection of electrical equipment, cables, earthing, lighting, fire alarm system, and preparation of layouts and other items covered in the scope of CONTRACTOR. This shall include but not be limited to the following

- 3.2.1 Basic and detail engineering activities for design of MRSS-100 substation building and co-ordination with Civil, Mechanical for cut-outs, cable trays, trenches, designing of air conditioning system, EOT crane, etc.
- 3.2.2 Design and engineering of electrical system for air conditioning system, EOT crane, etc.
- 3.2.3 Design and engineering of grid connected rooftop solar photovoltaic system comprising of array layout, SLD, mounting structure design, shadow analysis, etc., on the roof of substation building in P25 plot area.
- 3.2.4 Basic engineering calculations i.e. load analysis, load flow, short circuit, for selection of electrical equipments.
- 3.2.5 Design, engineering, sizing and selection of equipment and facilities comprising of switchboards, NIFPS, HV water spray system, DC system, UPS system, Fiber Optic transmission system, lighting transformer, etc. and submission of sizing calculation report for OWNER/ PMC review.
- 3.2.6 Overall single line diagram and protection & metering SLDs for individual switchboards, DC systems, UPS system, and auxiliary power supply system in CONTRACTOR's scope.
- 3.2.7 Cable sizing, illumination level calculation and preparation of power supply distribution scheme for normal, emergency and critical lighting, design calculation for earthing system (as per IEEE-80 in support of step and touch potential) and lightning protection system (as per IEC 62305) for the 220 kV GIS substation MRSS-100 .
- 3.2.8 Preparation of equipment layouts, lighting layouts, cabling layouts, earthing layouts, lightning protection layout, NIFPS piping layout, plant communication layouts, fire alarm layouts, telephone layouts, LAN system layout for 220 kV GIS substation (MRSS-100) Preparation of bill of materials for cabling, lighting, earthing and lightning protection, , plant communication, fire alarm, telephone system, LAN and miscellaneous items.
- 3.2.9 Preparation of system architecture drawings for Substation automation system.
- 3.2.10 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.
- 3.2.11 Calculation of requirement of IOs for ECS Interface Panels (transducer panel, Dummy panel, Interposing relay panel) and ECS RTU Panels etc. for interface of 220 kV GIS substation

package with client's ECS System. ECS interface panel shall be free issued by owner at MRSS-100. Installation of the same is in scope of contractor.

- 3.2.12 Relay Co-ordination studies including protection coordination charts, relay setting calculations; relay parameterization for complete system in scope of CONTRACTOR. ETAP Project files (i.e. \*.oti file) for the new system along with coordinated relay setting shall be provided by contractor. Contractor to verify and co-ordinate the relay settings with upstream 220kV feeders of SS-64 and hand over the updated ETAP project file (OTI file) to Owner/ EIL.
- 3.2.13 Preparation of miscellaneous engineering document such as electrical equipment list, lighting/ power panel schedule, cable schedule, interconnection drawing, ECS interface document, etc.
- 3.2.14 3D Modelling shall be done for substation buildings consisting of all the equipment like FA system, HVAC/VAM (including ducts), equipment layout (panels and transformers), etc. to avoid fouling of various systems and subsequent re-work. Also, cable tray and cable trench design in cable cellar of substation shall be reviewed in 3D model.
- 3.2.15 Preparation of specification for procurement of electrical equipment in CONTRACTOR's scope of supply, review of sub vendor drawings and then submission of electrical equipment drawing for review/ information, preparation of site executable (AFC) engineering drawings and details for installation work, wherever applicable.
- 3.2.16 Collection of data from Site/ Owner as required for carrying out detailed engineering.
- 3.2.17 Shop inspection and testing procedures and QA schedule.
- 3.2.18 Field testing and commissioning procedures.
- 3.2.19 Preparation of as-built drawings on completion of the project for final records.
- 3.2.20 Preparation of operation and maintenance schedule/manuals.
- 3.2.21 The CONTRACTOR while performing design and engineering activities shall adhere to following guidelines:
  - 3.2.21.1 CONTRACTOR, if not stated but required shall prepare any additional specifications for equipment or bulk material. CONTRACTOR shall follow current national & international standards/specifications for the equipment that are not covered by OWNER/ EIL's specifications.
  - 3.2.21.2 The drawings attached with tender define the basic system design and distribution philosophy for the package and are for guidance purpose only. CONTRACTOR shall develop detailed drawings and submit for EIL/owner review.
  - 3.2.21.3 Contractor to note that equipment ratings and quantity, wherever specified in the bid package shall be considered as minimum rating & quantity. Contractor shall be responsible to verify the same and provide equipment with higher rating & quantity subject to minimum rating as per bid package requirements. Compliance to the same shall be without any extra cost and time implications to owner.
- 3.2.22 Interface engineering and drawing, as required for the completeness of erection, testing and commissioning of electrical system.
- 3.2.23 Any other work/activity which is not listed above, but however found necessary for completeness and satisfactory operation of the electrical system.

### 3.3 SCOPE OF SUPPLY, ERECTION, TESTING AND COMMISSIONING

The electrical scope covered under this package includes but shall not be limited to supply erection, testing and commissioning of the following (**Equipment rating and specifications mentioned here are preliminary and approval has to be taken from EIL/owner before finalizing the rating and placing order**) :



Applicable only if  
mentioned in Bid  
Price Schedule

- 3.3.1 Extension by addition of 2 Number 220kV GIS bays in existing CG make 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear (1 no. bays at each bus section) with Local Control Cubicle and Separate control and relay panel complete with numerical relay, metering, protection and synchronization panel. Other details shall be shared with successful contractor. Make of 220kV GIS extension bays and associated LCC & CRP shall be of same make as existing. Regarding details of 220kV existing GIS & associated LCC, CRP, Contractor shall coordinate with BHEL (main execution contractor) & CG (220kV GIS OEM) and obtain the requisite details. UHF sensors for 2 nos. 220kV CG make GIS extension bays envisaged at existing 220kV substation shall be hooked up with existing PD monitoring system. All required hardware, software, interconnecting cable including modification in existing HMI is included in contractor's scope.
- 3.3.2 220 kV, 2000 Amps, 50 kA (3 Sec), Double Bus Gas Insulated Switchgear with Local Control Cubicle and Separate control and relay panel complete with numerical relay, metering, protection and synchronization panel at MRSS-100. Control and relay panel for GIS shall be simplex type.
- 3.3.3 Modification in existing 2 nos. 220kV spare CG make GIS bays at SS-64 (owner's substation) to accommodate owner's 220kV cable termination.
- 3.3.4 Communicable type power quality meter along with HMI shall be provided at all 220kV incomer feeders of 220kV switchboard envisaged at MRSS-100 for monitoring of various current & voltage harmonics at 220kV level. Communication protocol of this meter shall be selected by contractor so that same can be hooked up with 220kV SAS for centralised monitoring at ECS.
- 3.3.5 SCAP panel for 220kV GIS system shall be provided in MRSS-100. The SCAP scheme shall also include momentary paralleling of two separate grid supplies i.e. one set of grid supply through SS-64 & second set of grid supply through future 220kV/66kV grid connection.
- 3.3.6 4 Number of 220/66 kV, 160/200 MVA, ONAN/ ONAF, YNyn0, Z= 12.5% (-0% to +10%), Oil filled transformer with OLTC and RTCC and suitable for bidirectional power flow as per enclosed specification and datasheets. Power transformer shall be provided with Nitrogen Injection Fire Protection System (NIFPS) along with HVWS based fire fighting system. Also Online dehydration facility shall be provided and the RTCC Panel shall be with dual redundant AVR facility.
- 3.3.7 66kV, 2000A, 40kA (3 sec.), SF6 Gas Insulated, single phase, 3 phase enclosure or single phase enclosure busduct with all bends and flexibles comprising of the Gas monitoring devices, barriers, pressure switches, UHF PD sensors etc.
- 3.3.8 66 kV, 3150 Amps, 40 kA (3 Sec), Double Bus Gas Insulated Switchgear with Local Control Cubicle and Separate control and relay panel complete with numerical relay, metering, protection and synchronization panel. Control and relay panel for GIS shall be simplex type. 66kV outgoing feeder envisaged for power recovery turbine shall be suitable for bidirectional power flow. The hardware mentioned in datasheet (DS-0046) is minimum and any additional including scheme implementation to achieve bidirectional flow power shall be provided by Contractor without any time and cost implication to Owner/EIL.
- 3.3.9 1 No 6.6 kV, 800 Amps, 40 kA (1 Sec), Isolating breaker panel with earthing truck, lifting truck (wherever applicable) complete with numerical relay, metering and protection as per enclosed specification and datasheet. Note that Internal Arc Classification (IAC) rating of switchboard shall be 40 kA for 0.2 sec.
- 3.3.10 4 Numbers, 6.6/0.433 kV, 2500KVA (minimum), Off Circuit tap changer, Dyn11, oil filled distribution transformer with Energy Efficiency Level 2 as per IS 1180 (Part-1) including amendments for feeding normal & emergency substation loads.
- 3.3.11 415 V, 4000Amps (minimum), 65 kA (1 Sec) TPN Bus duct air insulated for connection between Transformer and Switchboard.



- 3.3.12 1 no. 415 V, 4000 Amps (minimum), 65 kA (1 Sec) and draw out type TPN switchboard (Power and Motor control center – PMCC) complete with numerical relay, metering and protection as per enclosed specification and datasheet. PMCC shall have two incomer from transformers and one incomer from rooftop solar photovoltaic system and bus coupler with auto changeover facility. Outgoing feeders shall be sufficient to cater CONTRACTOR load, Owner's load and spare feeders as per spare philosophy.
- 3.3.13 1 no. 415 V, 4000 Amps (minimum), 65 kA (1 Sec) and draw out type TPN switchboard (Emergency Power and Motor control center – EPMCC) complete with numerical relay, metering and protection as per enclosed specification and datasheet. EPMCC shall have one incomer from 6.6kV switchboard through 6.6/0.433kV transformer and second incomer from owner's substation SS-106 (CT-1) through 6.6kV IBP, 6.6/0.433kV transformer and bus coupler with auto changeover facility. Outgoing feeders shall be sufficient to cater CONTRACTOR load, Owner's load and spare feeders as per spare philosophy.
- 3.3.14 415 V, 400 Amps (Minimum), 25 kA for 1 Sec (Minimum) and draw out type TPN lighting distribution board (LDB) as per enclosed specification and datasheet for all the normal and emergency lighting transformer including those for owner's use. LDB shall have two incomer and one bus coupler. Quantity and rating/ type of outgoing feeders shall be sufficient to cater CONTRACTOR load, Owner's load and spare feeders as per spare philosophy.
- 3.3.15 Substation Automation System (SAS) is in the scope of supply of CONTRACTOR. Hardware for Substation Automation system includes all cables, Ethernet switches, gateway, FO cable, HMI, industrial grade laptop for interfacing with Numerical relays over IEC-61850 etc. Provision of hook-up of soft electrical control, monitoring and status signals to ECS system, SCAP system of MRSS-100 & SS-64 shall be provided in SAS. Software for all interfacing & control for Numerical Relays and other system components shall be installed in HMI and Laptop. All hardwired signals shall be connected upto the ECS interface panels by CONTRACTOR.
- Separate SAS shall be provided each for 220 kV GIS and 66kV GIS system at MRSS-100. Further common SAS shall be provided for 6.6kV & 415V system at MRSS-100.
- Interface between Contractor's SAS & owner's DCS is not envisaged. However for other connectivity of contractor supplied equipment, refer instrumentation part of tender.
- 3.3.16 Modification of existing SAS & ECS system interface for incorporation of extension panels for existing 220kV GIS at SS-64, including all hardware & software required as per existing systems design / make / model.
- 3.3.17 ECS of MRSS-100 is new & included in owner's scope (supply, testing & commissioning). However, installation of owner's supplied ECS panels i.e. interface panels (transducer panel, dummy panel, interposing relay panel) & RTU panel at MRSS-100 is kept in contractor's scope.
- 3.3.18 110V DC supply system comprising parallel redundant battery chargers, 2 x 50% Nickel Cadmium battery, DCDB, cell booster and online battery bank monitoring system, for switchgear protection & control including spare feeders and feeders for Owner's use as required. Existing 110V DC feeders available at existing 220kV GIS substation shall be extended by contractor for 2 nos. 220kV GIS extension panels. Contractor's scope shall start from outgoing terminal of 110V DC feeder module. Supply, laying & termination of cable is included in contractor's scope.
- 3.3.19 220V DC supply system comprising parallel redundant battery chargers, 2 x 50% Nickel Cadmium battery, DCDB, cell booster for critical lighting including spare feeders and feeders for Owner's use as required.
- 3.3.20 230V, Double Parallel Redundant UPS with Bypass (2+2 Design) and Ni-Cd battery backup (2 X 100%) with ACDB, Cell Booster and self-powered disturbance recorder with internal battery backup shall be provided for providing for control supply to ECS Panels, LAN, SAS HMIs, etc., installed in substation
- 3.3.21 4 nos. 415V/415V, Off Circuit, Dyn1, dry type lighting transformer for feeding normal & emergency lighting loads of substation buildings & outdoor switchyards. Note that minimum

rating of lighting transformers shall be considered as 100KVA (normal lighting) & 50KVA (emergency lighting) at MRSS-100. Telephone system for 220 kV GIS package including supply of telephone distribution JB, telephone handsets and wiring from JB upto telephone sockets in substation building.

- 3.3.22 LAN system for 220 kV GIS package complete with LAN wiring, UTP jacks, rack panels, LIUs and associated power sockets is included in CONTRACTOR scope. Connection with refinery LAN system shall be done by others.
- 3.3.23 MV Motors, as required. All MV motors shall be energy efficient IE3 type as per IS 12615.
- 3.3.24 Local control stations/ push button stations for motors/ transformers, lighting control, etc. as required. Lighting panel/ power panel/ Welding receptacles/ convenience sockets/ junction boxes/ marshalling panel, as required, industrial grade, suitable for installation in safe area.
- 3.3.25 Flameproof and corrosion proof, certified for gas group IIC classified locations equipment (Lighting fixture, exhaust fan, etc.) suitable for installation in battery room.
- 3.3.26 All incoming and outgoing, XLPE Insulated, armoured, FRLS type outer sheath MV cables for power, control and space heater complete with laying and termination accessories for equipment supplied by contractor.
- 3.3.27 All fibre optic cables (Single mode type only) required for communication between various equipment supplied & installed by contractor, shall be supplied, laid and terminated by the contractor including all accessories (termination kits, pig tails, LIUs, patch cords, etc.) as required.
- 3.3.28 All cabling accessories i.e. straight through joints, end termination kits, GI pipes, GI cable trays complete with structural supports, top and bottom tray covers, cable glands and lugs, cable markers, HDPE ducts for laying FO cables, etc. as required for the complete package inside substation building including cables being supplied and laid by owner/others.
- 3.3.29 Complete earthing and lightning protection system comprising of maintenance free chemical earth pit with Cu bonded high tensile low carbon steel core electrode, earth grid of MS Rods, earth plates, GI earth strips for earth connection between equipment and earth plates, lightning arrestors, earthing conductor, etc. as required for earthing and lightning protection of the various equipment.
- 3.3.30 Normal and Emergency lighting system comprising of lighting panels, LED type lighting fixtures with clamps/ connectors/ adaptors, for indoor and outdoor lighting, DC critical lighting, plug, socket, etc. as per design basis for the complete 220 kV GIS substation.
- 3.3.31 Free standing floor mounted type PDB for space heater outgoing supply to various switchboards/ bus duct/ other equipment, with 415 V, TPN incomer and 240 V SPN outgoing feeders as required.
- 3.3.32 Solar rooftop photovoltaic system consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU), etc. suitable for installation on roof of substation building of MRSS-100 in P25 plot area.
- 3.3.33 Electrics for various mechanical systems like EOT cranes, Air conditioning, etc. as applicable.
- 3.3.34 Fire-proof sealing system and fire protection coating system to prevent spreading of fire from one zone to another through the openings in wall / floor, along cables laid in trays / racks and through openings below floor-mounted Electrical Switchgear, PMCC, Distribution Boards, Junction boxes, Cabinets and Panels.
- 3.3.35 Canopies complete with fixing arrangement and hardware for all outdoor electrical equipment in scope of the CONTRACTOR.
- 3.3.36 Distribution boards for various DC & AC supplies.

- 3.3.37 One set of special tools and tackles, erection hardware and touch up paint as required, Start-up & commissioning spares, as required during commissioning.
- 3.3.38 Mandatory spares as per the spares list attached elsewhere in the document.
- 3.3.39 List of recommended spares for 2 years of normal operation and maintenance of all electrical equipments, along with unit rates and quantity.
- 3.3.40 All Civil works required for installation of electrical equipment, supports for cables/ cable trays, equipment foundations, etc., for completion of electrical works in substation CONTRACTOR shall include painting and marking of all buses, individual incomers, all outgoing feeders etc. with details such as tag no., feeder rating, CT details, sending end source reference etc. for all switchboards. Painting and marking of important parameters of all other indoor and outdoor equipments, lighting and FA devices, earth pits, etc. (supplied and/ or installed by CONTRACTOR) is also included in CONTRACTOR's scope.
- 3.3.41 Inspection and Factory Acceptance Tests including type tests for electrical equipment. Contractor shall also furnish factory acceptance and site acceptance testing procedures from manufacturers for OWNER/EIL approval. Site acceptance testing shall be included for equipment's such as numerical relays, substation automation system, etc. The equipment manufacturer shall carry out these tests at site only. Site testing procedures shall be got approved from OWNER/EIL before performing these tests at Site
- 3.3.42 For the following equipment, CONTRACTOR shall ensure that installation, testing and commissioning of the equipment at site shall be done by the respective equipment manufacturer (OEM):
- installation supervision
- 220 kV Double bus GIS and associated LCC
  - Control and Relay panel for 220 kV Double Bus GIS (Testing & Commissioning only)
  - 66 kV Double bus GIS and associated LCC
  - Control and Relay panel for 66 kV Double Bus GIS (Testing & Commissioning only)
  - Grid transformer including NIFPS & online moisture removal system
  - Power transformer including online moisture removal system
  - 6.6 kV switchboard & 6.6kV Isolating Breaker Panel (Testing and Commissioning only)
  - Numerical relays and Substation Automation System (Testing and Commissioning only)
  - MV switchboards (Testing and Commissioning only)
  - Complete DC System & AC UPS (Testing and Commissioning only)
  - Solar rooftop photovoltaic system.
- However for other equipment's, contractor shall ensure services of manufacturer's representative as required during testing and commissioning.
- 3.3.43 Contractor is advised to visit site prior to submission of bid in consultation with EIL/ IOCL to collect all interfacing data from site including details of existing equipment / systems which require augmentation / extension for successful execution of job. Contractor shall inform issues, if any along with their resolution to EIL/ IOCL and include the same in the scope of tender after obtaining concurrence from EIL/ IOCL.
- 3.3.44 Contractor shall carry out the installation, field testing and commissioning of all electrical equipment supplied as part of this package, including installation, assistance in field testing and commissioning of free issue items, provision of appropriate test and commissioning reports and as-built documentation as necessary for all but not limited to equipment and systems specified above.
- 3.3.45 The contractor shall obtain approvals from the concerned electrical inspectorate (e.g. CEA, State Authority etc.) for installation drawings and engineering of the electrical system and equipment covered under the contractor's scope. Any modification or additional requirements of the electrical inspectorate shall have to be carried out by the contractor at his own cost without affecting time schedule. Any additional testing, if required, shall be carried out by the contractor without affecting project time schedule at no extra cost to owner.

- 3.3.46 Providing training for TEN number OWNER' s Engineers for a period of at least three days for each item at Site for the following equipment's is included in the Contractor's scope:
- 220 kV Double bus GIS and associated LCC
  - Partial Discharge Monitoring of 220 kV GIS
  - Control and Relay panel for 220 kV Double Bus GIS
  - 66 kV Double bus GIS and associated LCC
  - Partial Discharge Monitoring of 66 kV GIS
  - Control and Relay panel for 66 kV Double Bus GIS
  - NIFPS of Power transformer
  - Online Dehydration Facility for transformer
  - Numerical relays and Substation Automation System
  - Complete DC System & UPS
  - Solar rooftop photovoltaic system.
- 3.3.47 All other electrical equipment materials and work not explicitly mentioned but nevertheless required to fulfil the following minimum requirements shall deemed to be included in the scope of the CONTRACTOR with no additional cost and time implication to the owner/ EIL.
- 3.3.47.1 To meet equipment and personnel safety.
- 3.3.47.2 To suit site facilities and environmental conditions.
- 3.3.47.3 To meet the requirements of statutory approving authorities.
- 3.3.47.4 To coordinate with other contractors and agencies involved at site for other activities and site work.
- 3.3.48 2 nos. 66/ 6.9 kV, 20/25 MVA, Z=10% (-0% to +10%), Dyn1, ONAN/ONAF transformer with OLTC and RTCC as per attached data sheet. Power transformer shall be provided with HVWS based fire fighting system. Also Online dehydration facility shall be provided and the RTCC Panel shall be with dual redundant AVR facility.
- 3.3.49 2 nos. neutral grounding resistor (3.81kV, 600A for 10 sec.) as per attached data sheet& EIL specification, 6-51-0043.
- 3.3.50 2 sets of 6.6 kV, 2500A, 40kA for 1sec. air insulated segregated phase bus duct as per enclosed datasheet. Drawing of MRSS-100 is attached with tender based on which length of bus duct shall be estimated by contractor.
- 3.3.51 1 no. 6.6kV, 2500Amps, 40kA (1sec.), AIS switchboard as per attached data sheet & feeder list for feeding package loads including owner's loads:
- Note: Supply, laying & termination of 6.6kV power & control cable from outgoing terminal of owner's feeders shall be taken care by owner. Cable route within battery limit shall be provided by contractor. Also the receiving end unit of feeder differential protection (87F) shall be free issued by contractor for installation at the downstream 6.6kV switchboard by the respective package contractor.
- 3.3.52 Design, supply, laying, termination (including termination kit), testing & commissioning of 66kV (E) copper conductor cable with aluminium corrugated sheath (1Rx1Cx300 sqmm.) from outgoing terminal of 66kV GIS switchboard of MRSS-100 to primary cable box of 20/25MVA (min.), 66/6.9kV transformer envisaged at MRSS-100 shall be supplied, laid & terminated by contractor. In this regard, contractor to follow the EIL standard specification, 6-51-0067 & data sheet.
- 3.3.53 Design, supply & laying of 66kV (E) cable from outgoing terminal of contractor supplied GIS switchboard to downstream individual package unit shall be done by others. However, termination of cable including 66 kV termination kits required at contractor supplied 66kV GIS at MRSS-100 shall be supplied by contractor.



Design, supply, laying, termination (including termination kit), testing & commissioning of 6.6kV (UE) cable shall be supplied, laid & terminated by contractor. Contractor to follow the cable data sheet & applicable EIL standard specification, 6-51-0051. Laying & termination of 6.6kV cable (except the owner's feeders) for contractor supplied equipment including termination kit is in scope of contractor.

- 3.3.54 2 nos. adequate rated indoor panel mounted capacitor bank each rated 50% of total rating with APFC relay at 6.6kV level for maintaining power factor at input of 66/6.9kV power transformer as 0.95 (lag). Each bank shall have vacuum contactor for ON/OFF control.

- 3.3.55 Contractor shall provide controlled switching device/synchronous switching device in each of the 220kV outgoing transformer feeders (including at all spare feeders) at 220kV GIS substation (MRSS-100) to limit voltage dip during closing of transformer incomer breaker. Details of CSD along with reference list of past executed projects & filed proven test record shall be furnished by the contractor for review/approval of EIL/owner. Contractor shall carry out transformer inrush current study for all EHV transformer under various operating conditions including charging through existing CPP SS-28 interconnected with SS-64. & shall submit the report to EIL/owner for review/approval.

### 3.4 FREE ISSUE EQUIPMENTS/ ITEMS

Following equipment/ items shall be free-issued by the owner to the contractor for Engineering/ Installation/ testing and commissioning as per scope of work defined:

- 3.4.1 220 kV Cables shall be supplied and laid by others.
- 3.4.2 220 kV termination kits for GIS shall be supplied by others. Termination of 220 kV Cables at 220 kV GIS end shall be done by others. scope break-up as per IEC
- 3.4.3 Fire Alarm devices for 220 kV GIS package substation building (MRSS-100) shall be supplied (free issued) by Owner. Preparation of fire alarm layout, block diagram and installation of fire alarm devices in MRSS-100 substation building as per approved layout including FA system cabling is in scope of CONTRACTOR. Testing and commissioning of Fire alarm devices shall be done by others.
- 3.4.4 Plant communication equipment for 220 kV GIS package substation building (MRSS-100) shall be supplied (free issued) by Owner. Preparation of PA layout, block diagram, speech diagram and installation of Plant communication devices in MRSS-100 substation building as per approved layout including PA system cabling is in scope of CONTRACTOR. Testing and commissioning of plant communication devices shall be done by others.
- 3.4.5 ECS System in 220 kV GIS substation (MRSS-100) shall be supplied, installed, tested and commissioned by others. MV power and control cables from CONTRACTOR's equipment to ECS Panels shall be supplied, laid and terminated by CONTRACTOR. Space for ECS panels shall be provided in the GIS building as specified elsewhere.
- 3.4.6 Receiving end unit of Feeder Differential relay for installation in 6.6 kV Isolating breaker panel will be free issued to the CONTRACTOR. Installation of relay shall be in scope of CONTRACTOR. Testing and commissioning of relay shall be by others.

### 3.5 INTERFACE WITH OWNER'S SYSTEM

Following interfaces with other plant system shall be in scope of CONTRACTOR. Contractor to also refer Interface drawing for detail.

- 3.5.1 Incoming 6.6kV cable up to 6.6kV IBPs shall be supplied and laid by others. However, termination of 6.6kV cable in IBPs shall be in scope of CONTRACTOR.
- 3.5.2 CONTRACTOR to supply Transformer + Feeder Differential Relay (87T+F) for installation in downstream switchboards outside package battery limit for each outgoing 66 kV transformer feeder. Relay shall be provided with redundant ports for OFC communication. Same OFC with

multiple fibers shall be used for redundant communication between these ports on relays at both ends. FO cable (single mode type only) and HDPE conduit for these differential relays shall be supplied Owner/EIL.

- 3.5.3 Receiving end unit of 87F relay in 6.6 kV IBP will be free issued to the CONTRACTOR. Installation of relay and connection to Ethernet switch on RJ45/ FO shall be in scope of this tender. Testing and commissioning of relay shall be by others. CT and end termination accessories of FO cable for 87F shall be in scope of this tender.
- 3.5.4 Space for installation of Panels & HMI for Online Temperature Monitoring System for 220kV incoming cables.
- 3.5.5 Cabling from CONTRACTOR's equipments (i.e. DC System, AC Supply, Space Heater supply, etc.) to Owner's DGFAP, ECS Panels, EPABX gateway etc., shall be supplied, laid and terminated at both ends by CONTRACTOR. Control cable (If any) from CONTRACTOR's equipments to Owner's DGFAP, ECS Panels, etc., shall be supplied, laid and terminated at both ends by CONTRACTOR.
- 3.5.6 Earthing of Owner's equipments installed in 220 kV GIS substation (MRSS-100) shall be in scope of CONTRACTOR. However, provision of earthing grid/ earth plates, including clean earth, if required, for ECS, shall be in scope of CONTRACTOR.
- 3.5.7 ECS system shall be in scope of OWNER. However, MV power and control cables from CONTRACTOR's equipment to ECS Panels shall be supplied, laid and terminated in ECS panels by CONTRACTOR. Connection of SAS to ECS shall be by ECS vendor. CONTRACTOR to provide redundant FO Port for connection with ECS.PA Junction Box and Telephone Junction box shall be supplied by CONTRACTOR. Incoming PA and Telephone cables shall be supplied and laid by OWNER. However, termination of these cables in PAJB and TJB shall be by CONTRACTOR.

## **4 EQUIPMENT SIZING AND SELECTION CRITERIA**

### **4.1 ELECTRICAL DESIGN BASIS**

- 4.1.1 Engineering design basis for electrical (B269-999-16-50-EDB-1001) & standard design philosophy for electrical facilities (6-51-0099) along with details indicates in this specification shall form the basis for basic design and developing detailed design and engineering for electrical facilities including electrical power system, electrical equipment and electrical installation etc.

### **4.2 EQUIPMENT SIZING**

- 4.2.1 The fault level for various voltage levels of Electrical system for this complex shall be limited and provided as under. Accordingly the associated electrical equipment shall be selected suitable for same:
  - i). 50 kA (RMS) (3 Sec)/ 135 kA (Peak) for 220 kV System.
  - ii). 40 kA (RMS) (3 Sec)/ 100 kA (Peak) for 66 kV System.
  - iii). 40 kA (RMS) (1sec.) / 100kA (Peak) for 6.6 kV systems.
  - iv). 65 kA (RMS) (1sec.) / 143kA (Peak) for 415 V System.
  - v). 25kA (RMS) (1 sec.) / 62.5 kA (Peak) for 415V System for LDB/ ELDB
- 4.2.2 CONTRACTOR to note that during sizing and selection of the equipment (i.e. oil filled and dry type transformers, DC system, UPS System, 415V switchboard, Ethernet switches, etc.), 20% spare feeders and 20% spare capacity (25% in case of DC System) shall be provided. This shall be over and above design margin.
- 4.2.3 CONTRACTOR to consider maximum cable de-rating factor of 0.5 for sizing of cables on ground rating at 30 degree specified in cable catalogue. This shall be considered for all underground cables.

- 4.2.4 CONTRACTOR to consider sizing factor for normal, standby and intermittent loads as per EIL Spec. 6-51-0099. Contractor to consider 10% design margin and 20% spare capacity for future.
- 4.2.5 CONTRACTOR to note that each switchboard/ transformer shall be loaded upto maximum 80% of its bus bar/ transformer capacity.
- 4.2.6 Lightning protection of building shall be designed for LPS level as per IS/IEC-62305 based on the geographical location of the package. Lightning strip size shall be minimum 25 x 3 mm.
- 4.2.7 Earth Resistivity Value shall be measured by CONTRACTOR before earthing system design calculation. For earthing conductor sizing, duration of earth fault current duration to be considered, shall be minimum one (1) second.
- 4.2.8 For lighting system design, overall maintenance factor shall not be more than 0.63
- 4.3 **SUBSTATION BUILDING**
- 4.3.1 Design, engineering and construction of Main substation building MRSS-100 in P25 plot areas included in the scope of CONTRACTOR. For detailed scope refer Civil/ Structural scope of work. Main Substation building MRSS-100 shall have cable cellar and battery room on ground floor and GIS Hall of double height, Switchgear hall, ECS Hall, UPS Room on first floor. Refer indicative architectural layout for detail wherein the minimum substation sizing requirements are indicated. Final substation building layout shall be developed and submitted by Contractor for review/ approval by EIL/Owner.
- 4.3.2 Cut-outs shall be provided along the complete length of switchgear hall. Beams in between cut-outs shall be provided with PVC sleeves of 150 mm dia. Opening of 200 x 100 mm shall be provided in all under slab beams of switchgear hall slab for FA cable laying. Cut-out of 1200 x 200 mm shall be provided in slab along columns on switchgear floor for cabling to wall mounted panels. Base frame work for all switchgear hall cut-outs is in scope of Contractor. All unused cut-outs shall be covered with 6 mm thick chequered plate after installation of all equipment. Cut outs provided for switchboards shall be covered with 6mm thick chequered plate during construction to prevent falling of people through cut outs.
- 4.3.3 All door/ gates in substation shall be provided with facility to padlocking the doors. Monorail shall be provided for equipment loading/ unloading.
- 4.3.4 All switchboards shall be installed considering provision for installation of two future panels on each side of switchboard.
- 4.3.5 CONTRACTOR to keep space for installation of Owner's ECS System panels in the switchgear hall. Approx. area of ECS Panel Room and ECS Operator Room is indicated in the architectural layout. Exact dimension of both the rooms shall be finalized during detailed engineering.
- 4.3.6 Structural support for Owner's supplied panels is also in the scope of CONTRACTOR. In addition to the base frame of panel, additional framework base channels for embedding in the concrete/ welding to the insert plates on concrete surface shall be supplied and erected by the CONTRACTOR. Supporting structure for 220 kV & 66 kV Cables from cable cellar to GIS structure shall also be provided by CONTRACTOR.
- 4.3.7 Power transformers shall be provided with a RCC oil soak pit below the transformer. Following guidelines shall be followed in this regard:
  - 4.3.7.1 The RCC oil soak pit shall be dimensioned such that the clearance between the pit extension and the transformer body shall be 20% of the height of the transformer (highest point) or minimum 800 mm beyond transformer body (Tank and Radiator) all around.
  - 4.3.7.2 For the transformers, which are having their soak pits connected to a common waste oil pit, the individual soak pit shall be sized to hold one third of the oil content of the particular transformer (Tank, Cooler, Conservator, OLTC and Cable Box) plus volume of water due to HV water spray system and a margin of approximately 20% for rain water.



- 4.3.7.3 However, the transformers with oil capacity more than 2000 litres, but not connected to waste oil pit, soak pit shall be sized to take the whole of the oil of the transformer plus 30% design margin.
- 4.3.7.4 The pit shall be filled with 40 mm size gravel and a porosity factor of 40% shall be considered for sizing of the pit.
- 4.3.7.5 Total pit volume shall also account for the transformer foundation or any other foundation in the pit.
- 4.3.7.6 Pit shall be raised at least 150 mm above the external level.
- 4.3.8 In addition, provision shall also be made to drain away the oil from individual soak pit to a separate waste oil tank/ pit, where use of more than 9,000 liters of oil in any oil tank/ pit or chamber is involved. This tank/pit shall be connected by a suitable Hume/ HDPE drain pipe of not less than 200 mm diameter to each soak pit. Waste oil tank/ pit shall be located away from the transformer, in the lowest part of the switchyard to assist drainage. The tank/ pit shall be of sufficient capacity to receive, without overflowing, the contents of the largest transformer plus the water of any fixed fire-fighting system and a certain quantity of rain water collected from all tanks/ pits. No other drain shall lead to the tank/pit. This pit shall be provided with an air vent large enough to avoid over pressure during operation. The whole internal surface shall be impermeable.
- 4.3.9 This pit shall not have stone filling. Suitable manhole with ladder shall be provided for the waste oil pit. For taking out the oil from the waste oil pit, a portable pump of suitable rating as per OISD-173 shall be provided.
- 4.3.10 Rail track/ Channel shall be provided for the movement of the main transformers. Same shall be extended on the main approach road. Mooring post shall be provided at a suitable location. Necessary arrangement along with suitable foundation shall be provided for jacking pad, wherever it is required to change the direction of transformer wheels.
- 4.3.11 Wherever cables cross the rail-track/ foundation, suitable size ducts in Concrete block shall be provided.
- 4.3.12 Main gate for power transformers and Maintenance Gates for routine operation & maintenance shall be provided in transformer bay. Transformer bays to be covered with concrete roof at double height.
- 4.3.13 Each transformer bay shall be provided with 1 Nos. 100 Amps outlet for oil filtration and other maintenance activities.
- 4.3.14 Fire wall between two adjacent transformers shall be extended at least 1 meter above the top most point of the Transformers. Fire wall shall also be designed to withstand the explosion of transformer bushing. Firewall thickness shall be minimum 355 mm in case of brick construction or 230 mm in case of RCC construction.
- 4.3.15 Battery room shall be well ventilated along with necessary exhaust system and water connection with sink. Battery room shall be provided with minimum two exhaust fans and louvered opening in the opposite wall/door. Floor of the battery room and walls up to 1.5 M height shall have acid/alkaline (as applicable) resistant protective material coating. Maintenance platform and wash basin/sink shall be provided in the battery room. Neutralization pit for battery room shall be considered, which shall be connected to plant drain.
- 4.3.16 Switchgear/ control room shall have fire-fighting equipment, first aid boxes, insulating floor mats all around the switchboards, hand-gloves and other safety equipment as per statutory requirements. Flooring of switchgear hall shall be painted with insulation paint.
- 4.3.17 Epoxy based insulation coating with breakdown voltage as per IS, suitable for installation on concrete flooring shall be applied on switchgear hall and GIS Hall of substation in air-conditioned/ non-air-conditioned area. Rubber mats shall also be provided around switchboards as per CEA safety regulations.

- 4.3.18 The fire-proof sealing system and fire protection coating system are required to prevent the spreading of fire from one place to another (or one zone to another) through the openings in wall / floor, along cables laid in trays / racks and through openings below floor-mounted Electrical Switchgear, PMCC, Distribution Boards, Junction boxes, Cabinets and Panels. The systems shall be installed in the specified locations in consultation with the purchaser's engineer after all cables have been laid and terminated.
- 4.3.19 Emergency escape route is mandatory to be maintained and marked from all locations in the cable cellar of substation.
- 4.3.20 Contractor shall note that 220kV & 66kV EHV cables inside cable cellar of MRSS-100 shall be laid in RCC trenches. Accordingly, required facility for the same shall be considered by contractor.

#### 4.4 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. Equipment s 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 GRID TRANSFORMER (220kV primary)

- 5.1.1 Tag Number for various transformers is as per table below:

| Tag Number | Rating                                                                                                          | Impedance                                     | Cable Termination                                                                                                                                                                  |                              |
|------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| TR-100011  | 220/66 kV,<br>160/200 MVA,<br>ONAN/ ONAF,<br>YNyn0,<br>OLTC -17.5% to<br>+12.5 % ( In step<br>of $\pm 1.25\%$ ) | $Z = 12.5\%(-0\%$<br>to $+10\%$<br>tolerance) | <b>At 220 kV Side</b><br>245 kV (E),<br>1 Run/ phase,<br>1C x 630 Sq.mm,<br>Cu Conductor,<br>XLPE Insulated,<br>Armoured,<br>Corrugated<br>Aluminium, PVC<br>Outer sheath<br>Cable | <b>At 66 kV Side</b><br>GIBD |
| TR-100012  |                                                                                                                 |                                               |                                                                                                                                                                                    |                              |
| TR-100013  |                                                                                                                 |                                               |                                                                                                                                                                                    |                              |
| TR-100014  |                                                                                                                 |                                               |                                                                                                                                                                                    |                              |

- 5.1.2 220kV grid transformer shall be as per the enclosed transformer datasheets and EIL standard specification 6-51-0068 attached with the tender. In addition to the requirements specified in 6-51-0068, following clauses shall also be complied.

- |                                      |   |                                        |
|--------------------------------------|---|----------------------------------------|
| a) Lighting Impulse Withstand        | : | 1050 kV <sub>p</sub>                   |
| b) Power Frequency Withstand         | : | 460 kV <sub>rms</sub>                  |
| c) Conservator for Cable Box         | : | Separate from main tank conservator    |
| d) Conservator for OLTC              | : | Common/ Separate, as per vendor design |
| e) Air Cell Puncture Detection Relay | : | Not Required                           |
| f) Sudden/ Rapid Pressure Rise Relay | : | Required                               |
| g) Automatic Regenerative Breather   | : | Not Required                           |

- h) Remote Indication for pressure relief devices : Through separate measuring system
- i) NIFPS System : Required separately for tank and 220 kV cable box
- j) HV Water Spray System : Required
- k) Rollers : Flat type
- l) 220 kV Termination : Oil insulated phase separated cable box with oil/ oil bushings
- m) 66 kV Termination : Phase separated cable chambers suitable for Gas Insulated Busduct termination
- n)
- o) Dissolve Gas Analyser : Required (Offline Type)
- p) Gases to be monitored : H<sub>2</sub>, CH<sub>4</sub>, C<sub>2</sub>H<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, C<sub>2</sub>H<sub>2</sub>, CO, CO<sub>2</sub>
- q) Online Moisture Removal System : Required (Refer doc. –SP-0023)
- r) OLTC : Bi-directional
- s) Microprocessor bases AVR Interface for communication : FO Port on IEC 61850. LIU shall be provided to terminate armoured cable.
- t) Impact Recorders : Required
- u) Type tests to be conducted on offered transformers, even if type test reports are available:
  - i. Temperature Rise : Required (One transformer of each rating)
  - ii. Loss Measurement : Required
  - iii. Short Circuit : Not Required
  - iv. Dielectric Test (As per IS 2026 Part 3) : Not Required  
For both transformer and cable box
  - v. Dissolved Gas Analysis of transformer Oil : Required
  - vi. Frequency Response Analysis : Required (At works and at site)
  - vii. Measurement of the harmonics of the no load current : Not Required
  - viii. Fault current withstand capacity test of 220 kV oil filled cable box. : Not Required
  - ix. Pressure Test : Required (On each tank size) & Cable box
  - x. Vacuum Test : Required (On each tank size) & Cable box
  - xi. Parallel operation : Yes
  - xii. SFRA test : To be done on all 220kV EHV Grid transformer at factory (before dispatch) & at site as part of pre-commissioning procedure.

5.1.2.1 Neutral point at 220 kV side shall be provided by means of the outdoor type bushing with minimum continuous voltage rating of 33 kV.

5.1.2.2 Contractor to ensure that valid type test certificates of offered design of transformer are available for Heat run test, short circuit test, IP test of panels, dielectric test, etc. as per type tests listed in IS:2026. In case of non-availability of short circuit test reports, dielectric test reports, IP test reports, impulse test reports, etc. same shall be conducted without any cost and time implication to Owner/ EIL. Type test certificates for EHV bushings and other transformer components shall

also be furnished. Type test of transformer shall only be acceptable provided the offered transformer have been manufactured from the same plant/works from where type tested transformer was manufactured..

- 5.1.2.3 The transformer cable chambers shall be provided with disconnecting arrangement for 220kV terminations to facilitate testing of cables and/or transformers independently. It shall also facilitate removal of the transformer without disturbing cables. The disconnecting arrangement can consist of links in the cable chamber or in a separate disconnecting chamber. The disconnecting arrangement shall be suitably insulated with provision of vermin proof breathing arrangement where applicable.
- 5.1.2.4 The clearances between the cable terminals and transformer bushings shall be adequate to subject each cable or transformer separately to high voltage tests. The cable box and the disconnecting arrangement shall be capable of withstanding both at the time of the first test on cables and at any subsequent time as required.
- 5.1.2.5 Supply of termination kits for entry of 220 kV cables in the oil filled chambers is excluded from CONTRACTOR's scope however all data / details required for procurement of same by owner and provision of required facilities & earthing connection shall be in CONTRACTOR's scope.
- 5.1.2.6 For each cable chamber of 220 kV cable terminal box, separate PRV shall be provided along with prismatic level gauges on both the legs of the cable chamber i.e. cable end and transformer end.
- 5.1.2.7 Separate conservator provided for 3-phase cable chambers shall be provided with a flexible oil resistance air bag and shall also be supplied with following accessories as a minimum :
  - Buchholz relay (double float type) with separate normally open trip and alarm contacts for each cable chamber connection
  - Prismatic level gauge
  - De-hydrating breather
  - Air release Device
  - Oil filling hole with cover
  - Oil Level indicator with alarm contact
  - Pressure relief valve shall be provided (with alarm contact).
  - Sampling valve
  - Conservator drain valve
  - Top oil filter valve
  - Drain cum bottom filter valve
  - NIFPS System
- 5.1.3 Buchholz relay, OTI & WTI shall be provided with reed type switches in place of mercury switches.
- 5.1.4 Supporting arrangement for raising the power cable to transformer end termination shall be provided.
- 5.1.5 Grid transformers shall be provided with OLTC and shall have RTCC facility.
- 5.1.6 Grid transformers shall be used for bi-directional flow of rated power. Tap changer shall be suitable for bidirectional power flow. The tap changer rating shall be more than maximum rated current of transformer at selected tap position and at ONAF rating.
- 5.1.7 CT for 51G and 64R shall be provided at both sides of transformer. CT for 51G shall be class 5P10 and CT for 64R shall be class PS for all the transformers. Technical details of class PS CT (CT Ratio,  $V_k$ ,  $I_{mag}$  and RCT) shall be submitted by contractor for EIL/owner review.
- 5.1.8 Grid transformer shall be transported with transformer tank/ OLTC/ terminal box/ etc. filled with dry air or nitrogen at positive pressure to ensure that no ingress of moisture, humidity or contamination takes place. 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 oil filling

during erection. A dry air or nitrogen pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.

- 5.1.9 Transformer shall be fitted 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.
- 5.1.10 GA of transformer shall be planned in such a manner, that it is possible to pull transformer tank outside the bay without withdrawing the radiators/ any other accessories of transformer.
- 5.1.11 Grid transformers shall be provided with Dissolved Gas Analyser (DGA) kit (This kit shall be supplied as Mandatory spare, defined elsewhere in this document). Provision shall be provided on tank and cable box for connecting the supplied DGA kit for online analysis
- 5.1.12 220kV EHV grid transformers shall be provided with Nitrogen Injection Fire Protection System (NIFPS) along with HVWS based fire fighting system. NIFPS shall be as per EIL specification attached with tender. NIFPS system shall be separate for cable box. Contractor to furnish PTR of NIFPS supplier before finalization of vendor.
- 5.1.13 Grid transformers shall be provided with Online Moisture Removal System. This systems shall be as per the specification attached with the tender. Contractor to furnish PTR of Online dehydration system supplier before finalization of vendor.
- 5.1.14 Bushing for voltage above 52 kV shall be RIP bushing with composite layer insulator. RIP type bushing shall be provided with tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable. Bushing shall be removable without disturbing the current transformer.
- 5.1.15 The Maximum Limit of value of tan delta shall be 1% for windings, 0.5% for bushings and 0.2 % for oil.
- 5.1.16 All the instruments, meters, etc., used for testing shall be duly calibrated at NABL laboratory and necessary calibration certificate shall be made available during inspection.
- 5.1.17 All transformers shall have WTI/ OTI transducer for interfacing with SCAP/ ECS. Duplicate set of terminals shall be provided for interface with SCAP and ECS. All contacts including “spare contacts” and “contacts for owner’s interface” shall be duly wired and terminated upto the terminal block.
- 5.1.18 All signals as per ECS IO List shall be provided for interface with the Electrical control system.
- 5.1.19 All internal wiring inside RTCC Marshalling Box etc. shall be with FRLS insulation.
- 5.1.20 Transformers shall be provided with emergency trip pushbutton station in the transformer bay. Push button station shall have Dual pushbutton with logic to press both for transformer trip.
- 5.1.21 As per Ministry of Environment, Forest and Climate Change (MoEF&CC), Regulation of Polychlorinated Biphenyls Order, 2016, manufacture and import of the Polychlorinated Biphenyls (PCBs) and PCBs containing equipment is banned and hence compliance of same in transformer oil shall be ensured.
- 5.1.22 Contractor to ensure that valid type test certificates for offered design of transformer are available for heat run test, short circuit test and impulse test. The same shall also be furnished for Owner’s review/approval during detail engineering. In case the valid type test certificates are not available, contractor shall carryout the type tests without any additional cost and time implication to Owner/EIL. In case of non-availability of short circuit test reports, manufacturer certified comparative statement in line with IEC-60076 part 7 / IS 2026 part 5 shall be furnished.

5.1.23 CONTRACTOR to also ensure the following:

#### 5.1.23.1 TRANSFORMER CORE

Core material type shall be low loss, non-ageing, high permeability PRIME GRADE, CRGO M4 Grade or better. Design of the core shall fulfil the requirements as listed below.

- It shall be perfectly insulated and clamped to minimize noise and vibrations
- Lower thickness material grades shall be used. Prime grade Cold rolled grain oriented M4 grade or better (Hi-B Grain Oriented Steel grades (HG-OS)) shall be used.
- Lap joints for core shall be of Step type.
- Yoke for the core shall be of boltless.
- The derived building factor shall range from 1.05 to 1.15.
- Certified Mill Test Report for core material shall be submitted.

#### 5.1.23.2 DESIGN CRITERIA

Following vendor data shall also be submitted for scrutiny after design finalization post order.

Yoke Lamination, Type of Core Joint, Number of Lamination/ Lay, Overlap length, Angle of Overlap, Gaps at Joint, Operational Flux density, Proportion of corner weight, X0/ R0, X/R, Z variation at  $\pm 10\%$  Tap position (@ ONAF) on Maximum, Normal and Minimum Tapping.

#### 5.1.23.3 OVER-EXCITATION TEST REPORTS

Over excitation conditions and test reports for the following level and duration of supply voltage shall be submitted post order for review by Client/ EIL.

- 110% continuous
- 125% for 1 min
- 140% for 5 sec
- 150% for 1 sec.

Over excitation graphs meeting the requirements specified above may also be accepted.

#### 5.1.23.4 CORE LAMINATIONS ASSEMBLY

Core lamination assembly shall be done while taking care of following points

- Shall be done appropriately (preferably using automatic pressure bed) to ensure that no air pockets are trapped within the laminations.
- Stage inspections of material during fabrication of the Laminations shall be carried out to ensure that only Prime material is being used.

#### 5.1.23.5 ACCREDITED LABS

Labs where heat run, loss measurements tests can be carried out shall either be CPRI Bhopal /Bangalore or any other NABL accredited labs under supervision of CPRI.



## 5.2 POWER TRANSFORMER (66kV primary)

5.2.1 Tag nos. of power transformer are as follows:

| Tag Number | Rating                                          | Impedance            | Cable Termination                                                                                                                                                  |                                                     |
|------------|-------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| TR-100031  | 66kV/ 6.9kV<br>20/25 MVA,<br>Dyn1,<br>ONAN/ONAF | Z=10% (-0% to +10%), | <b>At 66 kV Side</b><br>1 Run/ phase,<br>1C x 300 Sq.mm,<br>Cu Conductor,<br>XLPE Insulated,<br>Armoured,<br>Corrugated<br>Aluminium, PVC<br>Outer sheath<br>Cable | <b>At 6.9kV</b><br>Busduct<br>(phase<br>segregated) |
| TR-100032  | 66kV/ 6.9kV<br>20/25 MVA,<br>Dyn1,<br>ONAN/ONAF |                      |                                                                                                                                                                    |                                                     |

5.2.2 66kV power transformer shall be as per the enclosed transformer datasheets and EIL standard specification 6-51-0068 attached with the tender. In addition to the requirements specified in 6-51-0068, following clauses shall also be complied.

- a) Lighting Impulse Withstand : 325 kV<sub>p</sub>
- b) Power Frequency Withstand : 140 kV<sub>rms</sub>
- c) Conservator for OLTC : Common/ Separate, as per vendor design
- d) Air Cell Puncture Detection Relay : Not Required
- e) Sudden/ Rapid Pressure Rise Relay : Required
- f) Automatic Regenerative Breather : Not Required
- g) Remote Indication for pressure relief devices : Through separate measuring system
- h) HV Water Spray System : Required
- i) Rollers : Flat type
- j) 66 kV Termination : Phase separated cable chambers suitable for Gas Insulated Busduct termination
- k) Online Moisture Removal System : Required (Refer doc. –SP-0023)
- l) OLTC : Uni-directional
- m) Type tests to be conducted on offered transformers, even if type test reports are available:
  - i. Temperature Rise : Required (One transformer of each rating)
  - ii. Loss Measurement : Required
  - iii. Short Circuit : Not Required
  - iv. Dielectric Test (As per IS 2026 Part 3) : Not Required  
For both transformer and cable box
  - v. Measurement of the harmonics of the no load current : Not Required
  - vi. Pressure Test : Required (On each tank size) & Cable box
  - vii. Vacuum Test : Required (On each tank size) & Cable box
  - viii. Parallel operation : Yes

5.2.2.1 Contractor to ensure that valid type test certificates of offered design of transformer are available for Heat run test, short circuit test, IP test of panels, dielectric test, etc. as per type tests listed

in IS:2026. In case of non-availability of short circuit test reports, dielectric test reports, IP test reports, impulse test reports, etc. same shall be conducted without any cost and time implication to Owner/ EIL. Type test certificates for bushings and other transformer components shall also be furnished. Type test of transformer shall only be acceptable provided the offered transformer have been manufactured from the same plant/works from where type tested transformer was manufactured.

- 5.2.2.2 The transformer cable chambers shall be provided with disconnecting arrangement for 66kV terminations to facilitate testing of cables and/or transformers independently. It shall also facilitate removal of the transformer without disturbing cables. The disconnecting arrangement can consist of links in the cable chamber or in a separate disconnecting chamber. The disconnecting arrangement shall be suitably insulated with provision of vermin proof breathing arrangement where applicable.
- 5.2.2.3 The clearances between the cable terminals and transformer bushings shall be adequate to subject each cable or transformer separately to high voltage tests. The cable box and the disconnecting arrangement shall be capable of withstanding both at the time of the first test on cables and at any subsequent time as required.
- 5.2.2.4 Separate conservator provided for 3-phase cable chambers shall be provided with a flexible oil resistance air bag and shall also be supplied with following accessories as a minimum :
  - Buchholz relay (double float type) with separate normally open trip and alarm contacts for each cable chamber connection
  - Prismatic level gauge
  - De-hydrating breather
  - Air release Device
  - Oil filling hole with cover
  - Oil Level indicator with alarm contact
  - Pressure relief valve shall be provided (with alarm contact).
  - Sampling valve
  - Conservator drain valve
  - Top oil filter valve
  - Drain cum bottom filter valve
- 5.2.3 Bucholz relay, OTI & WTI shall be provided with reed type switches in place of mercury switches.
- 5.2.4 Supporting arrangement for raising the power cable to transformer end termination shall be provided.
- 5.2.5 Power transformers shall be provided with OLTC and shall have RTCC facility.
- 5.2.6 Power transformers shall be used for uni-directional flow of rated power. Tap changer shall be suitable for bidirectional power flow. The tap changer rating shall be more than maximum rated current of transformer at selected tap position and at ONAF rating.
- 5.2.7 CT for 51G and 64R shall be provided at both sides of transformer. CT for 51G shall be class 5P10 and CT for 64R shall be class PS for all the transformers. Technical details of class PS CT (CT Ratio,  $V_k$ ,  $I_{mag}$  and RCT) shall be submitted by contractor for EIL/owner review.
- 5.2.8 Power transformer shall be transported with transformer tank/ OLTC/ terminal box/ etc. filled with dry air or nitrogen at positive pressure to ensure that no ingress of moisture, humidity or contamination takes place. 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 oil filling during erection. A dry air or nitrogen pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.
- 5.2.9 GA of transformer shall be planned in such a manner, that it is possible to pull transformer tank outside the bay without withdrawing the radiators/ any other accessories of transformer.

- 5.2.10 Power transformers shall be provided with Online Moisture Removal System. This systems shall be as per the specification attached with the tender. Contractor to furnish PTR of Online dehydration system supplier before finalization of vendor.
- 5.2.11 Bushing for voltage above 52 kV shall be RIP bushing with composite layer insulator. RIP type bushing shall be provided with tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable. Bushing shall be removable without disturbing the current transformer.
- 5.2.12 The Maximum Limit of value of tan delta shall be 1% for windings, 0.5% for bushings and 0.2 % for oil.
- 5.2.13 All the instruments, meters, etc., used for testing shall be duly calibrated at NABL laboratory and necessary calibration certificate shall be made available during inspection.
- 5.2.14 All transformers shall have WTI/ OTI transducer for interfacing with SCAP/ ECS. Duplicate set of terminals shall be provided for interface with SCAP and ECS. All contacts including “spare contacts” and “contacts for owner’s interface” shall be duly wired and terminated upto the terminal block.
- 5.2.15 All signals as per ECS IO List shall be provided for interface with the Electrical control system.
- 5.2.16 All internal wiring inside RTCC Marshalling Box etc. shall be with FRLS insulation.
- 5.2.17 Transformers shall be provided with emergency trip pushbutton station in the transformer bay. Push button station shall have Dual pushbutton with logic to press both for transformer trip.
- 5.2.18 As per Ministry of Environment, Forest and Climate Change (MoEF&CC), Regulation of Polychlorinated Biphenyls Order, 2016, manufacture and import of the Polychlorinated Biphenyls (PCBs) and PCBs containing equipment is banned and hence compliance of same in transformer oil shall be ensured.
- 5.2.19 Contractor to ensure that valid type test certificates for offered design of transformer are available for heat run test, short circuit test and impulse test. The same shall also be furnished for Owner’s review/approval during detail engineering. In case the valid type test certificates are not available, contractor shall carryout the type tests without any additional cost and time implication to Owner/EIL. In case of non-availability of short circuit test reports, manufacturer certified comparative statement in line with IEC-60076 part 7 / IS 2026 part 5 shall be furnished.
- 5.2.20 CONTRACTOR to also ensure the following:

#### 5.2.20.1 TRANSFORMER CORE

Core material type shall be low loss, non-ageing, high permeability PRIME GRADE, CRGO M4 Grade or better. Design of the core shall fulfil the requirements as listed below.

- It shall be perfectly insulated and clamped to minimize noise and vibrations
- Lower thickness material grades shall be used. Prime grade Cold rolled grain oriented M4 grade or better (Hi-B Grain Oriented Steel grades (HG-OS)) shall be used.
- Lap joints for core shall be of Step type.
- Yoke for the core shall be of boltless.
- The derived building factor shall range from 1.05 to 1.15.
- Certified Mill Test Report for core material shall be submitted.

#### 5.2.20.2 DESIGN CRITERIA

Following vendor data shall also be submitted for scrutiny after design finalization post order.

Yoke Lamination, Type of Core Joint, Number of Lamination/ Lay, Overlap length, Angle of Overlap, Gaps at Joint, Operational Flux density, Proportion of corner weight, X0/ R0, X/R, Z variation at  $\pm 10\%$  Tap position (@ ONAF) on Maximum, Normal and Minimum Tapping.

### 5.2.20.3 OVER-EXCITATION TEST REPORTS

Over excitation conditions and test reports for the following level and duration of supply voltage shall be submitted post order for review by Client/ EIL.

- 110% continuous
- 125% for 1 min
- 140% for 5 sec
- 150% for 1 sec.

Over excitation graphs meeting the requirements specified above may also be accepted.

### 5.2.20.4 CORE LAMINATIONS ASSEMBLY

Core lamination assembly shall be done while taking care of following points

- Shall be done appropriately (preferably using automatic pressure bed) to ensure that no air pockets are trapped within the laminations.
- Stage inspections of material during fabrication of the Laminations shall be carried out to ensure that only Prime material is being used.

### 5.2.20.5 ACCREDITED LABS

Labs where heat run, loss measurements tests can be carried out shall either be CPRI Bhopal /Bangalore or any other NABL accredited labs under supervision of CPRI.

## 5.3 DISTRIBUTION TRANSFORMER

- 5.3.1 Maximum rating of distribution transformer shall be limited to 2500kVA however the transformer rating shall be finalized based on load analysis, considering 10% design margin and 20% capacity for future load. Each transformer shall be sized to feed the complete load independently
- 5.3.2 Transformers shall be provided with emergency trip pushbutton station in the transformer bay. Push button station shall have Dual pushbutton with logic to press both for transformer trip.
- 5.3.3 The transformers impedances shall be chosen to suit switchgear fault withstand capabilities and large motor start-up (if any).
- 5.3.4 Distribution transformer rated upto 2500kVA shall comply to latest IS-1180 (Part-1): 2014 and its amendments including but not limited to amendment-4 and latest Gazette of India Order. Accordingly, efficiency of transformer at 50% and 100% load shall be considered with total losses at 50% and 100% loading not exceeding maximum losses values specified in Table-6 of IS-1180 (Part-1) for Energy Efficiency Level-2.
- 5.3.5 The transformer shall bear standard mark of Bureau of Indian Standards in line with Gazette of India. Copy of license obtained from Bureau of Indian Standards in compliance with IS 1180(Part-1) shall be furnished by the contractor along with transformer vendor drawings post order.
- 5.3.6 The overall dimensions of the transformers shall be limited in accordance with 7-51-0337 enclosed with the package.
- 5.3.7 Bucholz relay, OTI & WTI shall be provided with reed type switches in place of mercury switches.
- 5.3.8 Fire fighting system is generally not envisaged for distribution transformers, accordingly, oil quantity for distribution transformer shall be restricted up to 2000 liters. In case, oil quantity is more than 2000 litre, HVWS system shall be provided by contractor.
- 5.3.9 CT for 51G shall be class 5P10 and CT for 64R shall be class PS for all the transformers. Technical details of class PS CT (Vk, Imag and RCT) shall be submitted by contractor for EIL review.
- 5.3.10 All transformers shall have WTI/ OTI transducer for interfacing with ECS.

- 5.3.11 All contacts including “spare contacts” and “contacts for owner’s interface” shall be duly wired and terminated upto the terminal block.
- 5.3.12 Contractor to ensure that valid type test certificates for offered design of transformer are available for heat run test, short circuit test and impulse test. The same shall also be furnished for Owner’s review/approval during detail engineering. In case the valid type test certificates are not available, contractor shall carryout the type tests without any additional cost and time implication to Owner/EIL. In case of non-availability of short circuit test reports, manufacturer certified comparative statement in line with IEC-60076 part 5 / IS 2026 part 5 shall be furnished.
- 5.3.13 Heat run test shall be done on one distribution transformer of each rating, even if type test report for same is available with the vendor. Pressure test and vacuum test shall be done on one transformer tank of each size.
- 5.3.14 All signals as per ECS IO List shall be provided for interface with the Electrical control system.
- 5.3.15 As per Ministry of Environment, Forest and Climate Change (MoEF & CC), Regulation of Polychlorinated Biphenyls Order, 2016, manufacture and import of the Polychlorinated Biphenyls (PCBs) and PCBs containing equipment is banned and hence compliance of same in transformer oil shall be ensured.
- 5.3.16 Transformers with 80% loading shall be equal to Peak Demand (including 10% design margin) & does not include 20% spare capacity for future.

#### 5.4 **EHV GAS INSULATED BUSDUCT (GIB) FOR 66kV**

- 5.4.1 Maximum weight of gas in gas tight section of GIB shall not exceed 250kg.
- 5.4.2 GIS bus ducts of each circuit shall be arranged in preferably horizontal formation and the clearance (outer to outer) between nearest bus ducts of two adjacent circuits shall be minimum one meter.
- 5.4.3 GIB shall be generally in only one horizontal layer. However in exceptional circumstance two horizontal GIB layers can be provided with the approval of owner/EIL and the vertical clearance between layers shall be minimum one meter in such case.
- 5.4.4 The minimum outer to outer horizontal clearance between each GIS bus duct shall be 0.5 meter.
- 5.4.5 The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters.
- 5.4.6 The horizontal clearance between GIB and GIS building /any other building wall shall be minimum three meters for GIB running parallel to the building/wall.
- 5.4.7 The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.
- 5.4.8 The GIB height outside the GIS hall in switchyard area shall not obstruct easy access to GIB, movement of crane for maintenance work.
- 5.4.9 For the maintenance of GIB of one circuit, only that circuit shall be isolated.
- 5.4.10 Contractor shall finalise the make of 66kV GIBD meeting the criteria indicated in attached Experience Record Proforma (ERP), B269-999-16-50-ERP-0021. Completely filled in ERP sheet along with all supporting documents shall be furnished along with bid.

#### 5.5 **HV & MV BUSDUCT**

- 5.5.1 Bus duct shall be provided for connection between the transformer and switchboards where the board rating is more than 1250A.
- 5.5.2 Note-4 of EDB doc. No. B269-999-16-50-1001 rev-0 (page 39 of 49) stands deleted and is replaced by following:

***“Non segregated phase air insulated type MV bus duct shall be provided in place of sandwich type busduct.”***

- 5.5.3 Bus-duct layout drawings shall be prepared by the CONTRACTOR based on substation equipment layout and Structural and Architectural drawings of substation and transformer drawings at the time of detail engineering.
- 5.5.4 It is CONTRACTOR's responsibility to close the gap between the bus-duct and the cut-out left for bus-duct routing. Closing of gap shall be done with material suitable for minimum 2 hours fire rating.
- 5.5.5 All other requirements for HV & MV Bus duct shall be as per EIL Specification 6-51-0054 and HV & MV bus duct datasheet attached with the tender.
- 5.5.6 All the offered HV, MV bus duct shall be type tested. CONTRACTOR to ensure at the time of order placement that copies of valid type test certificates for the following tests conducted on identical design of offered bus ducts are available.
- Short time current withstand test
  - Power frequency & lightning impulse voltage withstand capacity
  - Heat run test.
  - Ingress Protection test.
- 5.5.7 CONTRACTOR to conduct heat run test on each rating of MV bus duct at vendor's works as part of scope of this tender and no extra payment for the same shall be provided.
- 5.5.8 The busduct bus bar material shall be same as that used for switchgear busbar. In case different material are provided for busbar of switchboards/transformers and busduct, 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.
- 5.6.7 Relay Setting
- 5.6.7.1 Relay settings for other outgoing feeders in CONTRACTOR's scope shall be undertaken by the CONTRACTOR/ Vendor and CONTRACTOR/ Vendor shall furnish the relay setting chart and



relay coordination curves. During drawing review stage, vendor shall furnish numerical relay selection chart showing complete model no. of numerical relay and various functionalities offered meeting all requirements specified in tender.

- 5.6.7.2 Any other data required for relay setting to be done by the CONTRACTOR's shall be provided during engineering stage.
- 5.6.7.3 Design calculations for selection of relay setting and relay parameterization, relay coordination, providing relay-setting table & relay parameterization, etc. for all feeders is included in the CONTRACTOR's scope. Relay parameterization for all relays shall be provided and implemented by vendor.
- 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.
- 5.6.36 Requirements For Online Temperature Monitoring System For HV & MV Switchboards:
  - 5.6.36.1 Online Temperature Monitoring System (OTMS) for HV Switchboards at all critical point mentioned below shall be provided for each switchboard and isolating breaker panels. In each vertical, wireless sensors shall be located as per the following:
    - a. Each horizontal bus bar terminal/tap-off connection in busbar compartment.
    - b. Each cable /bus duct connection points in cable compartment.
    - c. One sensor per phase of cable connection points shall be considered irrespective of number of runs of cable.
  - 5.6.36.2 Online Temperature Monitoring System (OTMS) for MV Switchboards shall conform to the following: In each vertical panel, sensors shall be located as per the following :
    - i. For MV Switchboard (PCC/PMCC/EPMC) having Air circuit breaker panels:
      - a. Each horizontal bus bar terminal/tap-off connection in busbar compartment.
      - b. Each bus duct/cable connection points in cable compartment.
      - c. One sensor per phase of cable connection points shall be considered irrespective of number of runs of cable
    - ii. OTMS is not required for MCC, ASB, LDB & ELDB.
  - 5.6.36.3 The temperature sensors installed shall be suitable for wireless, with direct contact to hot point, operating range from -10°C to 125 °C. The accuracy shall be as per the following:  $\pm 3^{\circ}\text{C}$

accuracy for 0°C to 80 °C range.  $\pm 4^\circ\text{C}$  accuracy for full range (-10°C to 0°C and 80°C to 125 °C)

- 5.6.36.4 The system shall allow at least 1 configurable threshold (alarm).
- 5.6.36.5 OTMS system shall have the provision to send complete data to SAS/ Owner's ECS for monitoring and investigation. The system shall be online to immediately provide an abnormal temperature alarm (with identification/location of the abnormal temperature) to the owner's operator system.
- 5.6.36.6 Complete data of OTMS shall be accessible in the SAS (through switchboard level Ethernet switches) & associated SAS Laptop/ HMI. The protocol for communication shall be either IEC 61850 or MODBUS TCP/IP or MODBUS RTU or other open protocol and shall be decided by CONTRACTOR. Accordingly, protocol convertors/gateways at suitable locations as required shall be provided by CONTRACTOR for data integration on IEC 61850 protocol from Master Ethernet switch to Owner's ECS system.
- 5.6.36.7 Online temperature monitoring data shall be available in both owner's ECS as well as Substation Automation System (SAS). OTMS shall be integrated with owner's ECS.

#### 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 equipment shall be as follows:

| Tag Number | Item                                          |
|------------|-----------------------------------------------|
| 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  |

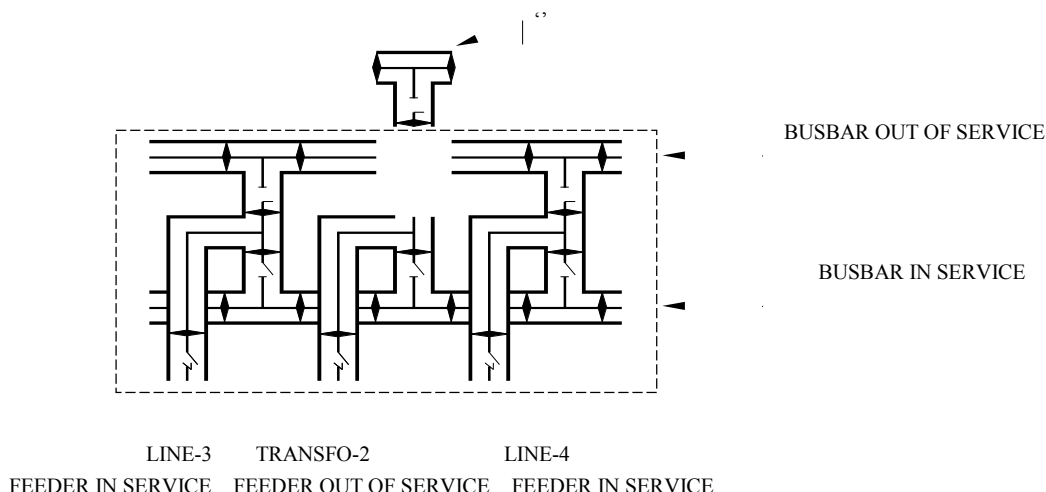
- 5.7.2 The equipment shall be designed for operation in applicable seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design 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. Validity of type test certificate applicable for 220kV, 66kV GIS switchboard & 66kV GIBD shall be considered as 'Till Design Change'. Type test certificate of parent company is also acceptable subject to meeting the tender & statutory requirement.

- 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.
- 5.7.6 Feeder differential relay (87F) matching with the make/ model as installed in the client's existing upstream 220 kV GIS feeder relay panel shall be supplied under scope of this tender. Testing and commissioning of this relay along with establishing of communication & any other requirement is also included in scope of CONTRACTOR. Make/model of existing relay shall be informed during detailed engineering.
- 5.7.7 Transformer+Feeder differential relay (87T+F) in the GIS CRP for 66 kV incoming feeders (including spare feeders), for installation in client's/other upstream 220kV/66kV panel through future grid shall be supplied loose (free issued by contractor) under scope of this tender.
- 5.7.8 Transformer + Feeder differential relay (87T+F) of same make/ model as installed in the GIS CRP for 66 kV outgoing transformer feeder (including spare feeders), for installation in client's/other downstream 6.6kV incomer panel shall be supplied loose (free issued by contractor) under scope of this tender. Testing and commissioning of loose supply relay is also included in scope of CONTRACTOR.
- 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 SF6 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 SF6 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 disconnector (when bus and bus disconnector 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 Adequate nos. of gas sectionalizer shall be provided in 220kV GIS & 66kV GIS for ensuring safety, ease of maintenance/repair & lower gas handling requirements during bus faults, regular maintenance/repair activities or extension work. Gas partitions shall be provided in GIS switchboard (220kV & 66kV) as per Fig: F.6 of IEC-62271-203 as a minimum. Typical sketch is as below:



- 5.7.9.6 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.
- 5.7.9.7 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.
- 5.7.9.8 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.
- 5.7.9.9 The thermal rating of all current carrying parts shall be minimum for three second for the rated symmetrical short-circuit current.
- 5.7.9.10 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.
- 5.7.9.11 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.
- 5.7.9.12 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.
- 5.7.9.13 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.

- 5.7.9.14 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.
- 5.7.9.15 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

- 5.7.9.16 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
- 5.7.9.17 The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The earthing system shall ensure safe touch & step voltages in all the enclosures.
- 5.7.9.18 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.
- 5.7.9.19 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.
- 5.7.9.20 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.
- 5.7.9.21 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.

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

5.7.9.23 **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

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

5.7.9.25 **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.

**5.7.9.26 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.

**5.7.9.27 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.

**5.7.9.28 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.

**5.7.9.29 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

**5.7.9.30 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.

**5.7.9.31 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.

**5.7.9.32 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

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

- i. Surge arrestor for GIS shall be installed within the GIS enclosure. Outdoor type surge arrestor 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 arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents and arrestor 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 arrestor 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.

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

**5.7.9.35 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.

**5.7.9.36 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.

**5.7.9.37 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.

**5.7.9.38 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.

**5.7.9.39 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 arrestor
  - 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 in EDB-1001 & SL-0020 attached with tender/technical amendment)
  - 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 cart

- 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 cart 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.
- 5.7.17 Contractor shall finalise the make of 66kV GIS switchboard meeting the criteria indicated in attached Experience Record Proforma (ERP), B269-999-16-50-ERP-0020. Completely filled in ERP sheet along with all supporting documents shall be furnished along with bid.
- 5.7.18 At all 220kV & 66kV feeders (incomer & outgoing) including spares, local breaker back up protection (LBB) shall be considered. Control logic shall be prepared accordingly.

5.7.19 Regarding the busbar differential protection envisaged in 220kV GIS & 66kV GIS, contractor shall note the following:

- a. Redundant & completely independent scheme shall be provided for main & check zone low impedance distributed differential protection with complete redundancy at both central as well as feeder CT input level for each of the main & check zone protection scheme. Redundancy of bus differential scheme to be ensured with two independent sets central unit each having independent main & check zone protection along with dedicated independent CT input modules for each feeder.
- b. Bus differential scheme shall have dedicated power supply from same bus section.

## 5.8 HV ISOLATING BREAKER PANELS

5.8.1 6.6 kV, 800 Amps, 40 kA (1 Sec) AIS Isolating Breaker Panel (1 no.) shall be as per EIL standard specification 6-51-0001. The switchboard shall be complete with metering, protection & control facility as per data sheet attached with tender. Tag number of various equipment shall be as follows.

| Tag Number | Item                                                    | Hardware Datasheet  |
|------------|---------------------------------------------------------|---------------------|
| HV-100211  | 6.6 kV, 800 Amps, 40 kA (1 Sec) Isolating Breaker Panel | B269-999-16-50-0074 |

5.8.2 The switchgear shall be qualified as classification IAC for rated fault current for 0.2 sec. for 6.6kV, according to IEC 62271-200 with regard to its mechanical strength in the event of an internal arc. The test performance shall be in conformity with accessibility type AFLR. The test shall be executed for all separate compartments within the functional unit containing HV equipment, i.e., bus-bar compartment, circuit breaker compartment and cable compartment.

5.8.2.1 In case contractor has considered pressure relief flap/gas duct above switchboard for release of gases due to internal arc, suitable absorbers in the switchboard shall be provided to prevent the release of harmful gases in the switchgear hall. Alternatively duct including all accessories/supporting arrangement/sealing material/bends/ installation material etc. shall be provided for taking the gas outside of substation to a safe location. Substation equipment layout shall be furnished during detailed engineering stage by contractor indicating duct location. This requirement is applicable for 6.6kV switchboard & all isolating breaker panels (6.6kV).

5.8.3 Vendor to note that all HV switchboards shall have Loss of service continuity category as LSC2B with partition class PM as per IEC-62271-200.

5.8.4 Separate earthing carriage/ truck shall be supplied for the IBPs. One set of earthing truck for incoming and outgoing cable side earthing shall be provided for IBPs. Two numbers of Lifting trucks and accessories (if applicable) shall be provided for IBPs for withdrawal of cassette mounted circuit breakers.

5.8.5 The validity requirements for the type test reports for HV switchboards , breakers etc. shall be as below :-

| S. No | Type Test                             | Equipment         | Validity                                                                        |
|-------|---------------------------------------|-------------------|---------------------------------------------------------------------------------|
| 1     | Short Circuit Withstand Capacity      | Panel             | Up to 5 years from the final bid opening date or design change which is earlier |
| 2     | Temperature Rise                      | Panel and breaker | Up to 5 years from the final bid opening date or design change which is earlier |
| 3     | Impulse and power frequency withstand | Panel             | Till any design change                                                          |
| 4     | Internal Arc Fault                    | Panel             | Till any design change                                                          |

| S. No | Type Test                             | Equipment | Validity               |
|-------|---------------------------------------|-----------|------------------------|
| 5     | Degree of protection for panels       | Panel     | Till any design change |
| 6     | Breaker short circuit duty cycle test | Breaker   | Till any design change |

- 5.8.6 In case the valid type tests on the offered design of Equipment is not available, all type tests shall be conducted by the successful vendor on the offered design after order finalization without any extra cost and delivery impact
- 5.8.7 Surge arrestor shall be provided at both incoming and outgoing of Isolating Breaker Panels. Sizing calculation of surge arrestors shall be furnished during drawing review stage.
- 5.8.8 IBPs shall be with single tier circuit breaker arrangement and shall be provided with online temperature monitoring system.
- 5.8.9 IBPs outgoing and incoming cabling compartment shall be provided with unique castle key rear door interlock such that breaker gets tripped/ does not gets closed, if rear door (through rear door limit switch) of that IBP is opened. In addition to that IBP rear door shall be interlocked with upstream switchboard breaker off contact, so that it shall not be possible to open the rear door, until upstream switchboard breaker is off. Rear door can be opened only when the breaker is switched off and racked out
- 5.8.10 Electrical interlock shall be provided for rear door of IBPs. Further, a mechanical interlock such as a trapped key interlock mechanism that does not permit opening of back cover until cable side earthing of outgoing breakers has been done.
- 5.8.11 Pressure relief ducts above switchboard for release of gases due to internal arc duct shall be considered as per manufacturer's recommendation and type tested design. In case pressure relief ducts are terminated inside switchgear hall, these shall be directed away/ upwards from person standing in the vicinity and shall be provided with absorber at both ends.
- 5.8.12 In each VCB panel, vendor shall ensure that two separate shutters have been provided, one for bus-side and one for cable side.
- 5.8.13 Vendor to note that an indication that defines 'ON', 'OFF', and 'in service position' shall be provided at the back side of all Isolating Breaker panel. Further, additionally, R-, Y-, B- Phase healthy indication shall also be provided.
- 5.8.14 Incoming and outgoing power cables to and from isolating breaker panels shall be as follows:
- **For 6.6kV IBP** : 1 Run 3C x 300 Sq.mm. 6.6 kV (UE), XLPE Insulated, Armoured, and FRLS Aluminium Cables separately for incoming from upstream feeder and to downstream 6.6/0.433kV distribution transformer.
- 5.8.15 The 6.6kV IBP will receive power from upstream 6.6 kV switchboard. Receiving end 87F relay for both the IBPs shall be also free issued to CONTRACTOR as part of this tender. Testing and commissioning of the receiving end relays is also included in CONTRACTOR scope. Optical fiber cable along with HDPE duct (Green conduit with white strip) shall be provided by others, however end termination of OFC including all accessories for receiving end shall be in the scope of this tender.

## 5.9 HV SWITCHBOARD

- 5.9.1 All requirements shall be considered while sizing the switchboards and feeders, as required, including feeder for free-issues material based on final approved single line diagram, shall be provided with no cost and time implication to owner. 20% spare capacity shall be considered for sizing of Switchboard.
- 5.9.2 HV Switchboard shall be provided with two incomers and two bus coupler. Second bus coupler shall be without any kind of numerical relay and shall be provided with Electro-mechanical type Trip circuit supervision relay. Status of second bus coupler shall be used in interlock of Auto

changeover logic, which shall be implemented in the first bus coupler with numerical relay. There shall not be any feeder in between two bus couplers.

- 5.9.3 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.
- 5.9.4 All feeders of HV Switchboard shall be provided with thermography window at rear side.
- 5.9.5 Transformer + Feeder differential relay (87T+F) of same make/ model as installed in the Upstream 66kV Switchboard at SS-100 shall be free-issued to CONTRACTOR for installation and wiring in 6.6kV Switchboard incomer panels. Testing and commissioning of loose supply relay is included in scope of CONTRACTOR.
- 5.9.6 CONTRACTOR shall supply (loose supply) Feeder differential relay (87F) of same make/ model as installed in the 2 Nos. 6.6kV Outgoing plant feeder for Owner's use for installation and wiring in downstream 6.6kV Switchboard incomer panels. Installation, Testing and commissioning of loose supply relays shall be done by others.
- 5.9.7 Auto changeover between incomers and bus coupler for 6.6 kV system shall be provided. Additionally manual change over through synchro-check relay with momentary paralleling shall also be provided. All necessary hardware shall be included to achieve auto, independent and manual operation of incomers and bus coupler.
- 5.9.8 Only major relays, meters and controls are indicated in the hardware data sheets. Any auxiliary relays, timers, switches, etc, as required while developing the control schematic and felt necessary for safe operation, even if these are not specifically included, shall be supplied by the CONTRACTOR. All logic shall be implemented in the relay itself and not externally. Provision of adequate I/O count in the relays shall be ensured.
- 5.9.9 All relays, metering and control components shall be mounted on the panel front only. Dummy panel and rear extension, as required, for bus trunking / cable terminations shall be provided.
- 5.9.10 Microprocessor based Fast bus transfer system shall be provided between Incomer-1, bus coupler-1 and incomer-2.
- 5.9.11 Auto/Manual Changeover with fast bus transfer scheme for switchboard with two incomers and one bus-coupler breakers shall comply with the logic described briefly as follows. Safety interlocks as deemed necessary shall however be considered during detailed engineering.

#### ***Auto/Manual Fast Bus Transfer***

The auto/ manual fast bus transfer scheme is described in brief as follows:

#### ***Facility to be provided***

- a) Auto fast bus changeover between the two incomers and one bus-coupler shall be in such a way that two incomer breakers are 'ON' at a time and bus-coupler breaker is normally open.
- b) Bus-coupler breaker is made 'ON' automatically in case the incoming supply at incomer breaker no. 1 or 2 fails in following modes:
  - i. Fast Transfer
  - ii. Delayed In phase transfer
  - iii. Residual voltage transfer (slow changeovers)
- c) Interlocks shall be continuously checked not limited to the following
  - i. Transfer system healthiness
  - ii. Breaker in service
  - iii. Breaker status & breaker contact integrity
  - iv. Master trip relay lockout condition (86)

- v. Breaker coil healthiness and breaker configuration
  - vi. PT in service and PT MCB condition
  - vii. Other source voltage healthiness
- d) Blocking of auto transfer (i.e., closing of bus-coupler) if any incomer breaker trips due to a fault.
  - e) Tripping of incomer on under voltage shall be blocked, if both the incomers simultaneously experience an under voltage.
  - f) The auto-change over shall be blocked during load shedding.

#### ***Normal operating condition***

Incomer no. 1 and 2 breakers are 'ON'. Bus-coupler breaker is 'OFF'.

#### ***Fast Transfer***

The bus voltage and incoming source voltage shall be monitored on a continuous basis for magnitude and phase angle and it shall be ensured that the same are within the specified limit values at the moment of initiation to ensure that transfer operation is carried out under conditions conducive to fast bus transfer as per high speed sync-check supervision. The open and close commands to the circuit breaker from the high speed transfer device shall be issued synchronously.

#### ***In-Phase Transfer***

If the synchronized conditions are not present the fast transfer shall be blocked. The supply breaker feeding to the bus opened and the bus-coupler is closed in the first minimum of the difference of healthy and bus bar voltage. The transfer system is able to determine the course of the difference voltage and the point in time of the 1st phase coincidence (first slip cycle synchronization). In order to compensate for the installation specific processing time like system response time, circuit breaker opening time etc. the close command is issued accordingly before the actual first minimum difference voltage occurs.

#### ***Residual voltage transfer***

When the criteria for a fast transfer operation are not met and in phase transfer is not feasible, the closing of breaker in fast transfer and in phase transfer is not possible, the residual voltage transfer shall be utilized. The closing of the bus coupler shall take place when the voltage of the bus bar has subsided to a preset, permissible safe value (20-30% of rated voltage).

#### ***Manual transfer***

- a) It is possible to trip incomer no. 1 or 2 after closing the bus-coupler to facilitate maintenance as required.
- b) When supply is again available at incomer breaker after auto changeover has already taken place, it is possible to restore the system to normal operating condition by operating selector switch (meant for tripping incomer no. 1 or 2 or bus-coupler) and by setting auto/ manual switch in 'Manual' mode.
- c) In manual transfer the closing circuit shall be checked through contacts of check synchronizing function during momentary paralleling.
- d) In manual transfer after momentary paralleling if desired breaker does not trip after preset time delay, breaker last closed shall trip.

#### ***Independent mode***

In addition to the transfer modes, all the incomer and bus-coupler breaker shall be desired to operate independently (ON-OFF operation) on independent mode for dead bus charging & other

maintenance requirement of switchboard. Paralleling of sources shall not be permitted in this mode.

Auto-Manual-independent (A-I-M) selector switch shall be provided in the switchboard for selection of different modes for operation.

Number of binary and analog inputs / outputs shall be adequate for the required system configuration.

FBT (Fast bus transfer) RELAY shall be physically located in Bus coupler panel or in any panel placed in the panel line-up only. All signal interchange between FBT relay & other panels shall be through inter-panel wiring only.

- 5.9.12 CT and PT burden mentioned in data sheets are indicative. CONTRACTOR shall provide the same as required including the burden for transducers provided at transducer panel. CONTRACTOR may consider 1.5 VA per phase per transducer for CT burden and 1.5 VA per phase per transducer for PT burden for analogue input for ECS interface.
- 5.9.13 DC and AC control supply scheme for HV switchboards shall be in line with hardware data sheet attached for HV switchboards.
- 5.9.14 All HV motor feeders schematics shall have provision for auto start and auto re-acceleration with feature to inhibit irrespective of process/licensor's requirement.
- 5.9.15 All HV switchboards shall have provision for positive LOTO implementation. Photographs of LOTO provision in each type of panels shall be submitted during drawing review for approval.
- 5.9.16 All requirements as specified above including ECS interface, shall be applicable for switchboard. Line PT and protection & metering requirements shall be as per Design data sheets and 6.6 kV hardware data sheets as applicable.
- 5.9.17 For interfacing with DCS system, separate Standalone Marshalling panel shall be provided in Substation. Hardwired signals (with minimum requirement specified below) from various feeders of a bus section required for DCS interface shall be wired and terminated in the standalone marshalling panel.
  - i) Breaker/Contactor 'ON' indication
  - ii) Breaker/Contactor 'OFF' indication
  - iii) Local/Remote selection indication
  - iv) Process Trip indication
  - v) Process Start command
  - vi) Process Stop command
  - vii) Process Start permissive command
  - viii) Ammeter (0-1A/4-20mA)
  - ix) Ready to Start signal from feeder
- 5.9.18 Terminals for DCS input & DCS 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.
- 5.9.19 Current rating for interface contacts shall be 2A, 110V DC.
- 5.9.20 All the signals available in Numerical relays shall be made available in Laptop & HMI through serial communication.
- 5.9.21 All signals as per ECS data sheet shall be provided for interface with the Electrical control system.



- 5.9.22 Number of analogue / digital IOs shall be worked out by the CONTRACTOR as per the ECS I/Os list attached with the bid package
- 5.9.23 All trip contact should be preferably “NO” contact. Separate NO contact of each such trip should be routed to relay also for event logging or redundant tripping.
- 5.9.24 All the CT connection should be through ring type reliable connection/terminations only.
- 5.9.25 There shall be one common control supply switch for all control supply of feeder. Separate fuses for following branch circuit shall be provided:
- Spring charging circuit
  - Closing circuit
  - Tripping circuit and contactor multiplier circuit & digital input circuit
  - Indication circuit
  - Numerical relay supply (incoming of numerical relay supply fuse shall be tapped before the “control supply switch”).
- 5.9.26 Separate control supply switch shall be provided for differential protection relays.
- 5.9.27 Control supply of each BUS PT of HV switchboard shall have independent control supply switch and sets of fuses tapped from Main DC bus.
- 5.9.28 Installation of surge arrestors to be done after the CTs towards cable termination side.
- 5.9.29 Hard contacts of the breaker shall be used for providing interlocks in the schemes mainly for auto change over, tripping, feedback, closing and process interlocks. In the absence of sufficient hard contacts, latched contactors/ relays to be used for contact multiplication.
- 5.9.30 Critical contacts used for providing process interlocks should be direct hard contacts and these shall not be taken from the multiplying contactors / auxiliary relays, if feasible.
- 5.9.31 Wherever two NO contacts available in Emergency push button & LCS STOP PB of all breaker fed HV Motors, one NO contact shall be wired to trip breaker directly & other shall be wired to binary input of numerical motor protection relay.
- 5.9.32 All rear panel doors of HV panels shall have handle for ease of maintenance.
- 5.9.33 The validity requirements for the type test reports for HV switchboards , breakers etc. shall be as below :-

| S. No | Type Test                             | Equipment         | Validity                                                                        |
|-------|---------------------------------------|-------------------|---------------------------------------------------------------------------------|
| 7     | Short Circuit Withstand Capacity      | Panel             | Up to 5 years from the final bid opening date or design change which is earlier |
| 8     | Temperature Rise                      | Panel and breaker | Up to 5 years from the final bid opening date or design change which is earlier |
| 9     | Impulse and power frequency withstand | Panel             | Till any design change                                                          |
| 10    | Internal Arc Fault                    | Panel             | Till any design change                                                          |
| 11    | Degree of protection for panels       | Panel             | Till any design change                                                          |
| 12    | Breaker short circuit duty cycle test | Breaker           | Till any design change                                                          |

In case the valid type tests on the offered design of Equipment is not available, all type tests shall be conducted by the successful vendor on the offered design after order finalization without any extra cost and delivery impact.

- 5.9.34 Contractor shall furnish details of type test certificate in attached format for Type test certificates Doc no. B269-999-16-50-DS-1030 during detailed engineering for review.

#### **5.10 NEUTRAL GROUNDING RESISTOR**

- 5.10.1 Neutral grounding resistor shall be supplied as per the EIL specification, 6-51-0043 & attached data sheet.

#### **5.11 EHV CABLE (66KV)**

- 5.11.1 66kV cable shall be supplied as per the EIL specification, 6-51-0067 & attached data sheet. Bonding scheme & associated hardware, jointing kit, termination kit, earthing cable etc. as required shall be decided & supplied by contractor.
- 5.11.2 Termination of owner's supplied & laid 66kV cable at outgoing terminal of 66kV GIS switchboard at MRSS-100 is included in contractor's scope. Accordingly, termination kit shall be supplied & commissioned by contractor.
- 5.11.3 Supply, laying & termination of 66kV cable on primary side of 66/6.9kV transformer to be supplied by contractor is included in contractor's scope.

#### **5.12 HV CAPACITOR BANK**

- 5.12.1 HV Capacitor shall be as per the enclosed HV capacitor datasheet and EIL standard specification 6-51-0020 attached with the tender.
- 5.12.2 Capacitor banks along with APFCR shall be indoor panel mounted type, installed in switchgear hall. Dry type series reactor, RVT installed inside panel shall be provided with the capacitor banks.
- 5.12.3 Capacitor bank and associated equipment shall be sized to maintain min. 0.95 power factor at the primary of 66/6.9kV transformers.

#### **5.13 MV SWITCHBOARD**

- 5.13.1 Refer enclosed hardware data sheets for the details of relay and metering facilities to be provided for each feeder. Only major relays, meters and controls are indicated in the data sheets. Any auxiliary relays, timers, switches, etc., as required while developing the control schematic and felt necessary for safe operation, even if these are not specifically included, shall be supplied by the contractor. All relays, metering and control components shall be mounted on the panel front only. All logic shall be implemented in the relay itself and not externally. Adequate I/O count shall be ensured.
- 5.13.2 The Contractor 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 contractor for Owner/ Consultant's review before proceeding with manufacturing.
- 5.13.3 Dummy panels and rear extensions, as required, for cable terminations, mounting of relays, meters, control components etc. shall be supplied as required and dummy/adopter panel for beam shall be considered for as per site requirements. Rear cable chamber provided for the switchboard shall be of height similar to other vertical panels.
- 5.13.4 All MV switchboards in contractor scope shall be of the same make.
- 5.13.5 Limiting maximum rating of PMCC/EPMCC shall be 4000A and fault level limited to 65kA for 1 sec.
- 5.13.6 The rating of MCC & ASB shall be limited to maximum 1250A.
- 5.13.7 All Incomers, Bus couplers and ACB power/motor feeders in MV Switchgear (PCC/PMCC/EPMCC) 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.

- 5.13.8 For PCC/PMCC/EPMCC internal arc protection system shall be provided to sense internal arc and to isolate the fault.
- 5.13.9 For MV Switchboards rated up to 4000A, forced cooling for any of the components e.g. bus bars, air circuit breakers etc. is not acceptable. To achieve the continuous current rating under site conditions at design ambient temperature inside the panel / cubicle, the required de-rating as / if applicable shall be considered by switchboard vendor.
- 5.13.10 MV switchboards shall be provided with facility to conduct test & disconnected operations with door closed position only.
- 5.13.11 All switchboards shall be provided with two incomer and one bus coupler. However, PMCC shall have third incomer for integrating solar photovoltaic system. No. of outgoing feeders shall be decided based on system requirement, spare feeders and feeders for Owner's use as defined elsewhere. However, feeders, as required, based on final approved single line diagram, shall be provided with no cost and time implication to owner. 20% spare outgoing feeder or minimum one of each type, whichever is higher shall be provided in each switchboard.
- 5.13.12 Air circuit breaker/Isolator provided in incomers of PMCC /EPMCC /MCC /ASB /LDB /ELDB shall be of 4-pole type. Isolating links shall be provided in the neutral circuit of all the TPN outgoing feeders
- 5.13.13 All the switchgears shall have rating at least equal to the maximum demand plus a provision for 10% future load growth and 20% spare capacity (i.e. Max. Demand x 1.1 x 1.2). Incomers of switchgear shall be designed to cater to the complete load including 10% margin for future load growth and 20% spare capacity as specified above. Service breaking capacities for all breakers shall be equal to or higher than the maximum value of the short circuit at the point of installation.

**5.13.14 Changeover scheme for three incomers and one bus-coupler**

PMCC shall be provided with Auto/ Manual Changeover facility. Auto/Manual Changeover scheme for switchboard with two incomers and one bus-coupler breakers shall comply with the logic described briefly as follows. Third Incomer of PMCC (i.e. Incomer from Solar PV system) shall be connected to the bus having emergency supply. Safety interlocks as deemed necessary shall however be considered during detailed engineering.

**5.13.14.1 Auto Changeover**

- i) Auto changeover between the two incomers and one bus-coupler shall be in such a way that the two-incomer breakers are 'ON' at a time and bus-coupler breaker is normally open.
- ii) Bus-coupler breaker is made 'ON' automatically in case the incoming supply at either of the incomer breaker fails and the respective breaker trips on under voltage.
- iii) Blocking of auto transfer (i.e., closing of bus-coupler) if any incomer breaker trips due to a fault or in case of standby earth fault (51G). Trip due to 64R, 63TX shall allow the transfer.
- iv) Tripping of incomer on under voltage shall be blocked, if both the incomers simultaneously experience an under voltage.

**5.13.14.2 Manual Changeover**

- i) Both the Incomer breakers are 'ON'. Bus-coupler breaker is 'OFF' Manual closing of bus-coupler with momentary paralleling (interlocked with check synchronizing relay) of the incoming supplies to facilitate taking out any of the incomer breakers for maintenance.
- ii) Trip any of the incomer breakers (pre-selected) after closing of any of the Incomer or coupler to avoid continuous paralleling of incomers.

**5.13.14.3 Initiation of auto changeover:**

- i) When the incoming supply to any of the breakers fails, the respective incomer is tripped through under voltage relays and a timer. The time delay is in the range of 0.5 to 5 sec. Breaker trip on under voltage is blocked in case of power failure on both the incomers.
- ii) The voltage on healthy bus section has been above the set value of normal voltage for a specified duration (settable through an off delay timer of range 0.5 to 5 sec) and the incomer breaker of healthy bus is closed in service position.
- iii) Bus-coupler is open and in-service position.
- iv) Auto / Manual switch is set for 'AUTO' operation.

**5.13.14.4 Closing of bus coupler breaker under auto operation:**

- i) One of the incomer breakers has tripped on under voltage.
- ii) The residual voltage on the bus that has lost supply is less than 40% of normal voltage.
- iii) Incoming voltage of healthy incomer has been above 80% of normal voltage for a specific duration (Through timer 0.5 sec to 5.0 sec)
- iv) Auto/ Manual switch is set for 'AUTO' operation.

**5.13.14.5 Manual transfer after auto changeover:**

- i) When supply is again available at incomer breaker after auto changeover has already taken place, it is possible to restore the system to normal operating condition by operating selector switch (meant for tripping incomer no. 1 or 2 or bus-coupler) and by setting auto/ manual switch in 'Manual' mode.
- ii) In manual transfer the closing circuit shall be interlocked through check synchronizing relay.

5.13.15 For interfacing with OWNER system, separate Standalone Marshalling panel shall be provided in Substation. Hardwired signals (with minimum requirement specified below) from various feeders required for ECS / DCS interface shall be wired and terminated in the standalone marshalling panel.

- i) Breaker/Contactor 'ON' indication
- ii) Breaker/Contactor 'OFF' indication
- iii) Local/Remote selection indication
- iv) Process Trip indication
- v) Process Start command
- vi) Process Stop command
- vii) Process Start permissive command
- viii) Ammeter (0-1A/4-20mA)
- ix) Ready to Start signal from feeder

5.13.16 Number of analogue / digital IOs shall be worked out by the Contractor as per the ECS I/Os list attached with the tender.

5.13.17 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

5.13.18 Current rating for interface contacts shall be 2A, 110V DC or 240V AC.

5.13.19 Indicating lamps shall employ LEDs. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.

- 5.13.20 All feeders shall have physical lock out provision to facilitate the “lock out tag out” (LOTO) procedure for ensuring safe operation
- 5.13.21 Two numbers ACB breaker handling trolleys shall be provided for the substation.
- 5.13.22 Earth fault relay operated through CBCT provided in PMCC & LDB feeders shall be mounted on draw-out part of the switchboard and shall be suitable for operation at 110V DC or 240V AC supply as available in the respective switchboard.
- 5.13.23 Timer provided in LDB shall be astronomical type smart timer i.e. to take care of weather condition & shall be programmable for full year.
- 5.13.24 For motor feeder rated up to 55kW, following shall be provided :
- R-C circuit shall be provided across the power contactor for all DOL motor starter feeders in PMCC.
  - Low burden auxiliary contactors shall be provided in all DOL motor starter feeders for receiving start/ stop commands from field.
- 5.13.25 All trip contact should be preferably “NO” contact. Separate NO contact of each such trip should be routed to relay also for event logging or redundant tripping.
- 5.13.26 All the CT connection should be through ring type reliable connection/terminations only.
- 5.13.27 There shall be one common control supply switch for all control supply of feeder. Separate fuses for following branch circuit shall be provided:
- Spring charging circuit
  - Closing circuit
  - Tripping circuit, contactor multiplier circuit& digital input circuit
  - Indication circuit
  - Numerical relay supply (incoming of numerical relay supply fuse shall be tapped before the “control supply switch).
- 5.13.28 Separate control supply switch shall be provided for differential protection relays.
- 5.13.29 Control supply of each BUS PT of PCC/EPCC/PMCC/EPMCC shall have independent control supply switch and sets of fuses tapped from Main DC bus.
- 5.13.30 Hard contacts of the breaker shall be used for providing interlocks in the schemes mainly for auto change over, tripping, feedback, closing and process interlocks. In the absence of sufficient hard contacts, latched contactors/ relays to be used for contact multiplication.
- 5.13.31 Critical contacts used for providing process interlocks should be direct hard contacts and these shall not be taken from the multiplying contactors / auxiliary relays, if feasible.
- 5.13.32 Wherever two NO contacts available in Emergency push button & LCS STOP PB of all breaker fed MV Motors, one NO contact shall be wired to trip breaker directly & other shall be wired to binary input of numeric motor protection relay.
- 5.13.33 All rear panel doors of MV panels shall have handle for ease of maintenance
- 5.13.34 Rear cable chamber provided for the switchboard shall be of height similar to other vertical panels and shall have handle for ease of maintenance.
- 5.13.35 All the offered switchboards and breakers shall be type tested. Copies of valid type test certificates for the following tests conducted on identical design of offered equipments required as per data sheets attached with tender specifications shall be furnished post order. The validity requirements for the type test reports for MV switchboards , breakers etc. shall be as below :-

| S. No | Type Test                             | Equipment         | Validity                                                                        |
|-------|---------------------------------------|-------------------|---------------------------------------------------------------------------------|
| 1     | Short Circuit Withstand Capacity      | Panel and breaker | Up to 5 years from the final bid opening date or design change which is earlier |
| 2     | Temperature Rise                      | Panel and breaker | Up to 5 years from the final bid opening date or design change which is earlier |
| 3     | Internal Arc Fault                    | Panel             | Till any design change                                                          |
| 4     | Degree of protection for panels       | Panel             | Till any design change                                                          |
| 5     | Breaker short circuit duty cycle test | Breaker           | Till any design change                                                          |

5.13.36 CONTRACTOR to conduct heat run test on each rating of MV switchboard at vendor's works as part of scope of this tender and no extra payment for the same shall be provided.

5.13.37 For owner supplied items, feeders at 415 V shall be provided by the CONTRACTOR in the PMCC switchboard supplied by them. Number of feeders required for Owner's use are listed below.

| S. No. | Description                                                           | PMCC | EPMCC | LDB                        | ELDB                       | Total Load*                   |
|--------|-----------------------------------------------------------------------|------|-------|----------------------------|----------------------------|-------------------------------|
| 1.     | FVNR 30                                                               | 4    | 2     |                            |                            | PMCC- 60KVA<br>EPMCC – 30KVA  |
| 2.     | FVNR 100                                                              | 3    | 2     |                            |                            | PMCC- 125KVA<br>EPMCC – 90KVA |
| 3.     | O/G Breaker Feeder with Numerical Relay – 800 Amps                    | 3    | 6     |                            |                            | PMCC-800KVA<br>EPMCC-1200kVA  |
| 4.     | SFU – 63 Amps with CBCT and ELR, Contactor                            | 4    | 2     |                            |                            | PMCC- 200KVA<br>EPMCC- 100KVA |
| 5.     | SFU – 160 Amps with CBCT and ELR, Contactor                           | 3    | 2     |                            |                            | PMCC- 100kVA<br>EPMCC- 100KVA |
| 6.     | SFU – 1 x 160 Amps + 4 x 63 Amps with CBCT and ELR, Contactor & timer |      |       | 2 + 2<br>(Indoor+ Outdoor) | 2 + 2<br>(Indoor+ Outdoor) | LDB- 25KVA<br>ELDB- 10KVA     |

\* Total Load of 1310 KVA of owner's load shall be considered in Normal distribution transformer sizing. Total load of 1530KVA of Owner's load shall be considered by Contractor for emergency distribution transformer sizing.

#### 5.14 RELAY AND CONTROL PANEL

5.14.1 Relay and control panel shall be as per EIL specification for Relay and control panels/desks, single line diagram and data sheets.



- 5.14.2 Panel shall be free standing, floor mounting, simplex panel with swing frame and protective full glass door in front.
- 5.14.3 Relay and Control panel shall be fed from separate dedicated 415V AC supply feeders, from Auxiliary switch board.
- 5.14.4 Closing and tripping coil of each breaker shall have a dedicated DC feeder.
- 5.14.5 The measuring instruments for Import/ Export purpose shall be taut-band type.
- 5.14.6 The captions to be engraved for various feeders / annunciators shall be finalised during detail engineering. Same shall meet the technical specification of C&R Panels as per HVPNL.
- 5.14.7 Semaphore indicator shall be used for isolator and earth switch, while for breakers, Discrepancy switches shall be used.
- 5.14.8 Testing facility for meters and relays shall be provided. For this purpose, necessary test blocks and test plugs shall be provided.
- 5.14.9 A digital clock suitable for DC supply shall be provided in a suitable position on the complete relay panel assembly.
- 5.14.10 Requirement of ICTs, stabilizing resistance and metrosil shall be decided by the contractor. Calculations to be furnished. For transformer feeders, stabilizing resistor shall be provided in residual earth fault connections to avoid spurious tripping during charging of transformer.
- 5.14.11 Synchronizing panel shall be provided as part of Relay and control panel. Synchronizing facility shall be provided to carry out the synchronizing for the 220 kV & 66kV GIS Incomers, Bus couplers, Bus-sectionalizer and tie breakers. Synchronization shall be from ECS as well as from this panel. Following operations shall be possible from Synchronization panel:
  - 5.14.11.1 Closing of all incomer breakers, bus couplers, bus Sectionalizer breakers, tie breakers (in service position) on dead bus condition (bus coupler/ bus sectionalising breakers dead bus closing to be checked on either side of the breaker).
  - 5.14.11.2 Synchronizing and closing of selected incomer breakers (in service position) and bus couplers/ bus sectionalising breakers/tie breaker (in service position) through check synchronizing.
  - 5.14.11.3 Required interlocks for safe operation shall be provided.
- 5.14.12 All signals as per ECS data sheet shall be provided for interface with the Electrical control system.
- 5.14.13 Number of analogue / digital IOs shall be worked out by the Contractor as per the ECS I/Os list attached with the bid package
- 5.14.14 Power quality meter, disturbance recorder & event logger, Main and back up distance relay, fibre optic transmission system for voice and data communication, cyber security requirements, etc. shall be complied as per requirement of CEA guidelines for grid connectivity and CEA guidelines for communication system. Specific requirement of HVPNL for power quality meters and other equipment listed above shall also be complied by the CONTRACTOR.
- 5.14.15 CONTRACTOR to note that relays, meters and other instruments used in HVPNL feeders shall be as per HVPNL specifications & requirements.

#### **5.15 NUMERICAL RELAYS AND SUBSTATION AUTOMATION SYSTEM**

- 5.15.1 Numerical relays shall be used in 220 kV GIS, 66kV GIS, 6.6 kV and 415 V switchgear.
- 5.15.2 All numerical relays shall be digital (microprocessor based) & communicable type as per EIL Standard Specification 6-51-0055 and datasheet for Numerical relay attached with tender.
- 5.15.3 All relays to the extent possible shall be sourced from same make. All the numerical relays of each switchboard shall be suitable for communication on IEC-61850 protocol and shall be connected serially/LAN topology to Ethernet Switches.

- 5.15.4 All protective relays and meters shall be provided with test terminal blocks for secondary injection testing.
- 5.15.5 All numerical relays shall comply with the prevalent emission and immunity levels.
- 5.15.6 All relays, metering and control components shall be mounted on the panel front only. All panels, relays and components shall be suitable for use in corrosive, humid, sulphurous environment. All relays shall be suitable for flush mounting, and fitted with dust-tight covers. The relay shall have a provision for testing using an external power supply without disconnecting the permanent wiring.
- 5.15.7 Hardwired lockout relay (86), Hand reset (VAJH) type shall be provided. PQ8 relay is not acceptable.
- 5.15.8 Differential relays (87), restricted E/F (64R) relay as asked for in the data sheet shall be separate relay and shall not be combined with the main protection relay.
- 5.15.9 The requirement of numerical relays and integration shall be in compliance with the requirement given in attached data sheet, and specification. Even though data sheets define the requirement in terms of discrete relays (electromechanical type) but numerical relay comprising all required functions shall be provided. Under voltage and Overvoltage relay along with associated timers shall be part of the numerical relay.
- 5.15.10 Numerical relays provided for motor feeders shall use in-built under voltage relay and timer for delayed tripping on bus under voltage.
- 5.15.11 Minimum 4 nos. inputs (DI) and 4 nos. outputs (DO) as spare shall be provided in each numerical relay.
- 5.15.12 Provision of manual bypass of 87B shall be provided in Numerical relays
- 5.15.13 Relay logic shall be ensured to not provide trip in case of DC failure & restoration
- 5.15.14 Scheme of switchboard shall be engineered to achieve the control logic, as required, through relay logic.
- 5.15.15 All relays shall be integrated to ECS for monitoring and control. Provision shall be provided for monitoring & control at HMI also. The relays shall be integrated based on basic system architecture attached with the tender.
- 5.15.16 Conformal coating shall be done for all electronic equipments as per grade 3C3 (Harsh environment) of IEC 60721-3-3. Alternatively, it shall comply with ANSI/ ISA S71.04 class G3 or IEC 60068-2-60 for mixed flow gas test or ASTM B845. Certification for batch of supplied items shall be submitted by vendor for the same.
- 5.15.17 All relays shall have communication port for direct access of data through laptop. One laptop common for all relays shall be provided for the following purposes:
  - 5.15.17.1 Retrieving data from numerical relays.
  - 5.15.17.2 Uploading settings & I/O configuration.
  - 5.15.17.3 Retrieving & viewing disturbance recorder data
- 5.15.18 The Numerical relays shall be provided with suitable hardware, software and communication ports for communication with minimum three different client sources simultaneously.
- 5.15.19 The redundancy in communication hardware shall be provided as per the data sheet attached. In ring topology, the communication shall have no disruption due to loop open circuit or failure of communication port. Also the switch off of DC supply to any or more relay should not affect the communication to rest of the relay. Moreover the ring should not be shared between the switchboards. For LAN where star couplers are used, the communication from star coupler to Ethernet switches shall be dual redundant. Relays of different switchboard should not be connected to the same star coupler. Similar to ring architecture, the failure of one star coupler

or failure of communication port or processor should not affect the communication of other star coupler to Ethernet switches.

5.15.20 **Refer Specification for Numerical Relays (Doc no. 6-51-0055)**, 20% spare ports shall be provided in each Ethernet switch provided in switchboard and in SAS.

5.15.21 All the data as available in the relay including the status of DI should be considered to be communicated to HMI. The data required for final configuration shall be finalized during engineering. Similarly whether specified or not, serial interface shall have no limitation for data transfer to ECS. However data as required for ECS interface shall be decided during engineering.

5.15.22 GPS antenna and hardware shall be provided for time synchronization. The resolution of time synchronization shall be  $\pm 1$  millisecond or better throughout the entire system. Suitable ports shall be provided in the GPS for hook up of Owner's switchboard numerical relays for future use.

5.15.23 Substation Automation System for switchgears shall be provided. It shall include Ethernet switches, laptop, HMI (Engineering cum operator workstation) and software to be installed for interfacing with Numerical relays over IEC-61850. Following substation automation system shall be in the scope of contractor.

| SAS Tag Number | For Equipment                   | Remarks                                                                    |
|----------------|---------------------------------|----------------------------------------------------------------------------|
| SAS-100921     | 220 kV GIS                      |                                                                            |
| SAS-100922     | 66 kV GIS                       |                                                                            |
| SAS-100923     | 6.6 kV IBP and 415V Switchboard | Separate Ethernet Switch in each IBP and MV switchboards shall be provided |
| Existing       | 220 kV GIS Extension Bays       | Extension of existing system for incorporation new bays to be done.        |

5.15.24 Redundant upper level Ethernet switch shall be provided for each SAS system in wall mounted cabinet.

5.15.25 Supply, laying and termination of all interconnecting cables from switch boards to Ethernet switches including cable termination kits and accessories in each substation is in CONTRACTOR's scope. FO cable for connection between switchgear and Ethernet switch shall be supplied and laid in HDPE duct (HDPE ducts shall be black conduit with blue strip for Relay LAN) which is also to be supplied and installed by CONTRACTOR.

5.15.26 DC System, UPS etc. shall be interfaced with SAS (Substation Automation System) on MODBUS TCP/IP.

5.15.27 Two Laptops are envisaged for the EHV, HV & MV switchboards in the project hence software as required for interface with Numerical relays of EHV switchboard and HV/MV switchboard shall be loaded by the switchboard Vendors in the Laptop provided. Following Laptops shall be in the scope of contractor.

5.15.27.1 Laptop for 220 kV GIS & 66kV GIS switchboards. Software if required for interface with GIS SF6 Analyser, PD Monitoring system, etc. shall be loaded in the Laptop provided

5.15.27.2 Laptop for 6.6 kV IBP and 415V Switchboards. Software required for interface with Numerical relays of 6.6 kV & 415V switchboards shall be loaded in the Laptop provided.

5.15.28 Laptop with Windows-10 or latest tested & compatible windows version and other required licensed software, hardware, accessories (serial data cables, VGA Cables, HDMI Cables, and USB Cables etc.) and materials shall be supplied as defined in the tender. The communication port on laptop shall match as that provided on the front of numerical relay. System configuration

shall be latest proven model and upgradable. The minimum configuration for this project shall be Intel i7 processor, 1 TB HDD, 4 GB RAM, DVD R/W Multi Drive, 15" LED screen, 4 nos. USB Ports (minimum), Ethernet Port, RS-232 Serial Ports, HDMI Port, etc. Further, laptop shall have compatible ports and compatible hardware for interfacing with transformer gas analysis, GIS SG6 analyser, PD Monitoring, etc. systems.

5.15.29 Laptop provided with SAS shall have functionalities specified under clause 6.4.1, 6.4.5 and 6.4.6 of 6-51-0055 attached with tender.

5.15.30 HMI with Windows-10 or latest tested & compatible windows version and other required licensed software, hardware, accessories (serial data cables, VGA Cables, HDMI Cables, and USB Cables etc.) and materials shall be supplied as defined in the tender. System configuration shall be latest proven model and upgradable. The minimum configuration for this project shall be Intel i7 processor, 1 TB HDD, 4 GB RAM, DVD R/W Multi Drive, 21" LED screen, 4 nos. USB Ports (minimum), Ethernet Port, RS-232 Serial Ports, HDMI Port, etc.

5.15.31 Laser printer shall be provided configured for line by line printing

5.15.32 Software for substation automation along with integrating hardware as required shall be supplied as a part of Laptop. Functionality minimum but not limited to the following shall be carried out. Customized software for substation application shall be supplied in non-returnable CD/DVD/USB Drive. Contractor to submit function design specification and screenshots of the various screen for Owner's review.

- Relay parameterization
- Control
- Disturbance record
- Data logging
- Annunciation
- Event/ status monitoring (including DI& DO of relays)
- Feeder status monitoring
- Event recording, motor starting transients, fault analysis etc.
- Analogue signal monitoring and metering
- Self-supervision
- Single Line Diagram
- View of historical data and generating trends
- Preparation of maintenance schedule

5.15.33 HMI shall be provided for disturbance recorder and power quality analyzer. The Power quality meter shall share the recorded data with the electricity regulatory commission. Power quality meters shall have facility to measure and meter the harmonics complying with provision of IEC 61000-3-4 Class A. In addition to harmonics, power quality meter shall have provision to monitor voltage sag, swell, flicker, disruptions, etc. Facility for waveform analysis shall also be provided.

#### 5.15.34 **FACTORY ACCEPTANCE TEST**

FAT shall be conducted for project simulation. FAT procedure shall be prepared and submitted for Owner's review. The methodology shall be mutually agreed to verify the system simulation and intended specification of tender document. All graphics and navigation between different pages shall be configured to Owner's satisfaction and successful commissioning.

#### 5.15.35 **SITE ACCEPTANCE TEST**

SAT shall be conduct to verify the actual simulation and shall be verified for required functionality and the scan time. Any modification as required to meet the tender document requirement and customization modification due to Owner's site engineer in charge shall be carried out with no commercial implication.

5.15.36 For system architecture, refer system architecture drawing attached with tender.

#### 5.16 **DC SYSTEM**

- 5.16.1 The DC system shall be as per EIL standard specification 6-51-0019 and DC System datasheet attached with tender. Battery shall be Medium Discharge type. Minimum temperature for battery sizing shall be 5°C.
- 5.16.2 DC system configuration shall be as per sketch attached with the Design Basis.
- 5.16.3 110V DC system complete with Ni - Cd battery bank, battery charger & DCDB supplied for Switchgear protection and control shall be provided with 2 x 50% battery banks.
- 5.16.4 220V DC system complete with Ni - Cd battery bank, battery charger & DCDB supplied for critical lighting shall be provided with 2 x 50% battery banks.
- 5.16.5 25% spare capacity shall be considered while sizing the battery and battery charger. 20% spare feeders of each type and rating shall be provided in DCDB.
- 5.16.6 3 Pole switch shall be provided for battery isolation purpose. Battery Isolator shall not be located inside battery room.
- 5.16.7 Battery charger shall be SMPS based.
- 5.16.8 DC Earth fault monitoring relay shall be provided on the battery charger.
- 5.16.9 DCDB shall be provided with voltmeter & selector switches which have facility to check DC positive to negative, positive to earth & negative to earth voltage. Annunciation for same shall be provided and indicated to ECS also
- 5.16.10 Busbar to be provided on TOP in DCDB.
- 5.16.11 ECS Interface for each DC System shall be provided as per ECS I/O list.
- 5.16.12 Battery charger output interlocking system shall not be MCCB based.
- 5.16.13 All inter-cell & inter row links shall be of copper with lead coating. Aluminium links are not acceptable.
- 5.16.14 Online battery bank monitoring system shall be provided for 110V DC System battery banks. Provision for individual cell voltage shall be monitored and alarm shall be provided. Battery monitoring system shall have connectivity with ECS system and remote alarm facilities.
- 5.16.15 For the following loads, completely independent redundant feeders from different bus sections of the DCDB shall be provided to the respective loads as minimum :
  - 5.16.15.1 220kV GIS / CRP
  - 5.16.15.2 66kV GIS / CRP
  - 5.16.15.3 6.6kV switchboard
  - 5.16.15.4 Electrical control system (ECS)
  - 5.16.15.5 Online moisture removal system
  - 5.16.15.6 415V PCC/PMCC
  - 5.16.15.7 Substation Automation System Panels
  - 5.16.15.8 Nitrogen Injection Fire Protection System panel
  - 5.16.15.9 Any other equipment based on reliability point of view & client requirement.
- 5.16.16 Battery charger for DC System shall be installed in Air-Conditioned area but it shall be suitable for operation in non-air-conditioned area also. Battery backup time shall be 120 minutes for both DC system.
- 5.16.17 Both DC system shall be kept in Substation switchgear hall. Ni-Cd Batteries for DC system shall be installed in a separate battery room. Both the DC system shall be of same make.
- 5.16.18 Diode droppers for battery charger shall be provided to limit the load voltage to nominal voltage.



- 5.16.19 Battery stand shall be in Double row double tier execution.
- 5.16.20 All cable glands and lugs are in scope of vendor.
- 5.16.21 Current feedback of each battery bank shall be provided to both the rectifiers so that in case of failure of one rectifier, another rectifier can control/ regulate the charging current of both battery banks.
- 5.16.22 The height of DCDB panel shall be same as that of battery charger.
- 5.16.23 Clearance between gland plates to terminating point shall be minimum 300mm in all the electrical equipment
- 5.16.24 Each of battery banks is to be located in a common battery room. CONTRACTOR to furnish number of air changes required to make the battery room safe i.e. non-hazardous. CONTRACTOR to furnish the proposed layout of battery rack in battery room maintaining 750 mm minimum clearance on all sides of battery rack.
- 5.16.25 All electrical equipment installed in battery room must be flameproof type suitable for gas group IIC.
- 5.16.26 DISCHARGE DUTY REQUIREMENTS FOR OWNER'S LOAD:

Load as per below mentioned table shall be considered for Owner's switchgear control supply and critical lighting in respective DC system to be located in Main GIS Substation MRSS-100 in P25 area.

| DC System                        | Nominal DC voltage | Duty cycle   |              |             |
|----------------------------------|--------------------|--------------|--------------|-------------|
|                                  |                    | First 1 min. | Next 58 min. | Last 1 min. |
| DC System for switchgear control | 110V               | 60 Amps      | 40 Amps      | 50 Amps     |
| DC System for Critical Lighting  | 110V               | 15 Amps      | 15 Amps      | 15 Amps     |

5.16.27 FEEDER REQUIREMENTS FOR DCDBs:

| DC System                        | Rating of each outgoing feeders | Number of Outgoing feeders |
|----------------------------------|---------------------------------|----------------------------|
| DC System for switchgear control | Upto 63 Amps                    | 10 Feeders                 |
| DC System for Critical Lighting  | Upto 32 Amps                    | 6 Feeders                  |

This feeder requirement is over and above the requirement of feeders for items free issued by owner and does not include any spare feeders. Same to be located in Main GIS Substation in P25 area.

5.16.28 **Following clause-wise modifications / additions to standard specifications shall be applicable on Specification for Battery Charger (EIL Spec. 6-51-0019):**

5.16.28.1 Note-2 on Page 13 & 14 of specification

**Addition:** "Battery isolator (MCCB/Switch Fuse) shall be provided with three pole version to ensure positive isolation of all the three connections of battery".

5.16.28.2 Cl. no. 5.2.1.8 Battery Charger:

**Addition :** "Perforated sheet/Wire Mesh shall not be provided at the bottom of the charger as over a period of time these gets corroded / damaged resulting in easy access of vermin's. Heat transfer system inside the charger shall be designed considering this aspect"

5.16.28.3 Cl. no. 5.2.2.7 Printed Circuit Board :



**Addition:** “Battery charger PCB electronic cards shall have conformal coating as per grade 3C3 (harsh environment) of IEC 60721-3-3 and certification for batch of supplied items shall be submitted by vendor for the same.

5.16.28.4 Cl. no. 5.3.1 Construction of Chargers / Distribution Board

**Modification:** “Each Battery Charger and DC distribution board shall be housed in a separate free standing cubicle with minimum IP-41 degree of protection, with common items for charger-1 & 2 housed in a separate vertical panel.....”

**5.17 UPS SYSTEM**

- 5.17.1 UPS system shall be as per EIL Specification 6-51-0017 and UPS system datasheet attached with the tender.
- 5.17.2 UPS system configuration shall be Double Parallel redundant with Individual bypass as per sketch attached with the Design Basis. Bypass shall have static or servo controlled voltage stabilizer.
- 5.17.3 230V AC UPS system complete with 2x 100% Ni - Cd battery bank & ACDB shall be provided for Control supply of Thyristor Control Panel, VFD, ECS, LAN system etc.
- 5.17.4 20% spare capacity shall be considered while sizing the battery and UPS. 20% spare feeders of each type and rating shall be provided in ACDB.
- 5.17.5 3 Pole switch shall be provided for battery isolation purpose. Battery Isolator shall not be located inside battery room.
- 5.17.6 UPS system shall be provided with additional separate earth bus for earthing of Isolation transformer. This earth bus shall be separate from earth bus provided for body earthing.
- 5.17.7 Online battery bank monitoring system shall be provided for 110V AC UPS System battery banks. Provision for individual cell voltage shall be monitored and alarm shall be provided. Battery monitoring system shall have connectivity with ECS system and remote alarm facilities.
- 5.17.8 ECS Interface for each UPS System shall be provided as per ECS I/O list.
- 5.17.9 Outgoing feeders with isolation transformer shall be provided with HRC type switch fuse on primary side and semi-conducting type fuse along with switch on secondary side. Outgoing feeders without isolation transformer shall be provided with semi-conducting type fuse.
- 5.17.10 Wherever, isolation transformers are required to be earthed to maintain output voltage in grounded condition, earth bus shall have punched holes for earthing of isolation transformers.
- 5.17.11 DC to DC convertor between UPS charger and battery bank is not acceptable i.e. battery bank float voltage shall be equal to charger float voltage.
- 5.17.12 All inter-cell & inter row links shall be of copper with lead coating. Aluminum links are not acceptable.
- 5.17.13 Disturbance recorder shall have at least two analogue channels with sampling rate of 1ms or better for monitoring of both UPS output at one place. Disturbance recorder shall have minimum features:
- Capacity to record at least 5 disturbances of 3 second each -
  - Disturbances shall triggered based on settable under voltage level. -
  - Option of settable pre - & post time
  - Shall have facility to take the data to laptop through USB/ suitable communication port.
  - Disturbance should be stored in “first in first out” mode without any manual intervention.
- Separate disturbance recorder is not required in case features mentioned at above for disturbance recorder are provided as part of FDU/UPS HMI based controller or voltage monitoring relays on the UPS output is provided with the disturbance recording features.

Regarding requirement of two analogue channels mentioned under "Disturbance Recorder" please note that the same is meant for monitoring the dual redundant UPS output voltages.

- 5.17.14 Busbar to be provided on TOP in ACDB.
- 5.17.15 For the following loads, completely independent redundant feeders from different bus sections of the ACDB shall be provided to the respective loads :
  - 5.17.15.1 LAN System Racks
  - 5.17.15.2 Substation Automation System Panels
  - 5.17.15.3 ECS System Panels
  - 5.17.15.4 Any other equipment based on reliability point of view & client requirement.
- 5.17.16 FEEDER REQUIREMENTS FOR UPS ACDB:

| UPS System        | Rating of each outgoing feeders | Number of Outgoing feeders |
|-------------------|---------------------------------|----------------------------|
| For ECS System    | Upto 5kVA                       | 10 Feeders                 |
| For EPABX gateway | Upto 500VA                      | 8 Nos.                     |

This feeder requirement is over and above the requirement of feeders for items free issued by owner and does not include any spare feeders. Same to be located in Main GIS Substation MRSS-100 in P25 area.

- 5.18 **FIRE DETECTION AND ALARM SYSTEM**
  - 5.18.1 Fire alarm system shall be engineered in line with the specifications attached with the bid document for all areas within battery limit including buildings.
  - 5.18.2 Fire Alarm devices (i.e. DGFAP, detectors, MCP, hooters, HAB, exit sign, input module/ control module) shall be supplied by Owner as free issue items (FIM) and quantities of same are as mentioned elsewhere in the tender. In case quantity required by CONTRACTOR is more than the indicated FIM, contractor shall supply the additional quantity without any time & cost implication. The make of these additional equipment/devices shall be of identical make, type & model no. as that of the free-issued equipment/devices.
  - 5.18.3 Fire alarm system as required for unit/area including buildings within package battery limit shall be engineered by CONTRACTOR. CONTRACTOR will prepare the fire alarm layout for the building. Owner will free issue the FA devices as per the final approved layout within the limits as mentioned elsewhere in the tender.
  - 5.18.4 Installation of all Free Issued Materials for Fire Alarm System and cabling including supply & laying of cables up to DGFAP for all field equipment in line with approved calculations shall be done by contractor. Installation shall be carried out as per installation details/ instruction details/ precautions provided by FA system manufacturer, approved Fire Alarm layouts, specification attached, approved sizing calculations and block diagram.
  - 5.18.5 Interface cabling with air-conditioning system, NIFPS, HVWS and other systems shall be provided by contractor as applicable.
  - 5.18.6 Testing and commissioning, of the Owner supplied fire alarm system will be done by others (Fire Alarm Vendor). However, contractor shall extend all necessary help and manpower to Fire Alarm vendor for executing works such as cable connection, disconnection and reconnection, detector removal, re-installation required during testing and commissioning of the system.
  - 5.18.7 FAJB (Metallic), as required shall be in scope of CONTRACTOR. Fire alarm cabling inside building shall be done using armoured cables. Unarmoured cable will be used as a special case in concealed conduits only subject to Owner's approval.

- 5.18.8 Tinned copper cable lugs for termination of 1.5 sq.mm. multi stranded fire alarm cables in all indoor and outdoor equipments including panels, detectors, BGU, hooters, relay modules, exit signs, JB's, etc. shall be considered by CONTRACTOR. Cable glands with PVC shrouds for all indoor and outdoor equipments including panels, detectors, BGU, hooters, relay modules, exit signs, JB's, etc. shall also be considered by the CONTRACTOR.
- 5.18.9 All hardware used for installation and cable tags shall be of SS 304 grade.
- 5.18.10 CONTRACTOR to furnish the details of control voltage of various systems like NIFPS system & HVAC system for designing of tripping contact by FA system manufacturer. CONTRACTOR to furnish tripping philosophy for HVAC system including tripping of VAM package and AHU package during engineering stage.
- 5.18.11 Maximum number of Fire Alarm system equipments considered in OWNER's scope of supply for installation in MRSS-100 by contractor, shall be as listed below. Any requirement over and above the listed quantities shall be in contractor's scope. The make of these additional equipment/devices shall be of identical make, type & model no. as that of the free-issued equipment/devices. Make & model no. of free-issued fire alarm equipment and fire alarm cable sizes shall be informed to the Contractor during detail engineering
- Data gathering cum fire alarm panel (DGFAP) – 1 no.
  - Intelligent addressable multi sensor detector – 375 Nos.
  - Intrinsic safe intelligent addressable heat detector – 18 Nos.
  - Linear Beam detectors – 12 Nos.
  - Manual call point (MCP) safe area type – 12 Nos.
  - Electronic hooters addressable – 7 Nos.
  - Exit signs addressable (Single faced) – 8 Nos.
  - Exit signs addressable (Double faced) – 4 Nos.
  - Hooter Acknowledgement Box – 4 Nos.
  - Relay Module – 6 Nos.
  - Input module – 16 Nos.
  - Fault Isolator Module – 25 Nos.

## 5.19 PLANT COMMUNICATION SYSTEM

- 5.19.1 Plant communication system shall be engineered in line with the specifications attached with the bid document for all areas within battery limit including buildings.
- 5.19.2 Plant communication devices (i.e. Master call station, Operator Call station, Field Call Station, Loudspeaker, beacon lamp, etc.) shall be supplied by Owner as free issue items (FIM) and quantities of same are as mentioned elsewhere in the tender. In case quantity required by CONTRACTOR is more than the indicated FIM, contractor shall supply the additional quantity without any time & cost implication. The make of these additional equipment/devices shall be of identical make, type & model no. as that of the free-issued equipment/devices.
- 5.19.3 Plant communication system as required for unit/area including buildings within package battery limit shall be engineered by CONTRACTOR. CONTRACTOR will prepare the plant communication layout for the building. Owner will free issue the devices as per the final approved layout within the limits as mentioned elsewhere in the tender
- 5.19.4 Installation of all Free Issued Materials for Plant Communication System, PAJB and cabling including supply of PAJB and supply & laying of cables up to PAJB for all field equipment in line with approved layouts shall be done by contractor. Installation shall be carried out as per installation details/ instruction details/ precautions provided by Plant Communication system manufacturer, approved layouts, specification attached, approved sizing calculations and block diagram.
- 5.19.5 Testing and commissioning of the Plant Communication system will be done by Owner/others (Plant Communication Vendor). However, contractor shall extend all necessary help and

manpower to Plant communication vendor for executing works such as cable connection, disconnection and reconnection required during testing and commissioning of the system.

- 5.19.6 Weatherproof Junction box (Metallic), shall be considered in 220 kV GIS substation building suitable for 1 runs of 50P cable, for receiving incoming cable from Owner's PA System Exchange. Termination and glanding of incoming cable in PAJB is in scope of CONTRACTOR. Contractor to note that minimum 5P cable shall be considered for each FCS and OCS/MCS.
- 5.19.7 Plant Communication cabling from PAJB onwards to the MCS, OCS, FCS, amplifier, loudspeaker, etc. shall be done by CONTRACTOR. Cabling inside building shall be done in concealed conduits using un-armored cables. Tinned copper cable lugs shall be considered for termination of multi stranded cables in all equipments. Cable glands with PVC shrouds for all equipments shall also be considered by the CONTRACTOR
- 5.19.8 All hardware used for installation and cable tags shall be of SS 304 grade.
- 5.19.9 Maximum number of Communication system equipments considered in OWNER's scope of supply shall be as listed below. Any additional requirement over and above the listed quantities shall be in contractor's scope. The make of these additional equipment's shall be of identical make, type & model no. as that of the free-issued equipment's. Make & model no. of free-issued plant communication equipment's and PA communication cable size shall be informed to the Contractor during detail engineering.
- Master Call Station – 1 Nos.
  - Operator Call Station – 2 Nos.
  - Field call station & weatherproof loudspeakers 25W (FCS + Ext loudspeaker) – 6 Nos.

## 5.20 TELEPHONE SYSTEM

- 5.20.1 Telephone system equipments as specified in scope of work shall be supplied, installed, tested and commissioned as per the specifications of this package.
- 5.20.2 Indoor Telephone Distribution Junction Box (TDJB) suitable for minimum 25 telephones shall be made out of 2.03 mm (14 gauge) sheet steel with Krone type terminals and with hinged lockable door. TDJB shall be provided with one anti-rust coat of primer and two finished coats of epoxy paint.
- 5.20.3 CONTRACTOR to note that incoming cables upto TDJB inside 220 kV GIS substation building shall be supplied and laid by others. However, termination and glanding of cables in TDJB JB is in scope of CONTRACTOR.
- 5.20.4 CONTRACTOR shall supply, install, test and commission flush mounting, plug - in type sockets for telephones including supply of sheet boxes with covers.
- 5.20.5 CONTRACTOR scope includes wiring from TDJB onwards to telephone sockets in concealed conduit.
- 5.20.6 Analog push button telephone handset to be supplied shall have the following functionalities :
- Redial / flash buttons.
  - Ringer volume control.
  - Hands free dialling.
  - Two way speaker phone.
  - Desktop/wall mountable.
  - Caller ID facility.
  - Minimum 99 incoming and 10 outgoing no. storage.
  - Display of real time and date.
  - Programmable flash.
  - Alphanumeric 16 Digit Backlit LCD display without any battery or adopted in put power and shall display date, time, caller number & name at a time.
  - Minimum 50 Names phone book.

- Should have Music on hold.
- Adjustable ringing tone.
- Telephone set should work on both tone & pulse mode.
- Dual mode FSK / DTMF system compatible with auto detection
- Telephone set & Ringer should be compatible with Openscape 4000 V8 type of system
- Telephone Sets should be supplied with battery, rosette, line cord & coil cord.

#### 5.21 LAN SYSTEM

- 5.21.1 CONTRACTOR scope includes supply, installation, testing and commissioning of LAN system comprising of CAT 6A modular UTP jack including all connected material (i.e. face plate, surface mounted box, patch cord, etc.), circuit wiring from Ethernet switch rack to CAT 6A UTP Jack using CAT 6A LSZH UTP cables, CAT 6A modular patch cord.
- 5.21.2 CONTRACTOR to note that minimum three 5A convenience outlets with switch shall be provided along with each LAN UTP Jack.
- 5.21.3 CONTRACTOR to note that connection of LAN system with refinery LAN shall be done by others

#### 5.22 MOTORS

- 5.22.1 MV Motors, if required, shall be energy efficient IE3 type as per IS 12615 and shall meet the requirements as per EIL standard specification 6-51-0064 and datasheet for MV motors attached with tender.
- 5.22.2 Motors installed outdoors shall have canopy (2 mm thick G.I. sheet steel) for additional weather protection.
- 5.22.3 The cable entries of all Terminal Boxes of motors, before dispatch from motor manufacturer works, shall be fitted with suitably sized IP-55 Metallic Sealing Plugs to prevent water entry/ingress in motor windings through openings meant for cable entry in terminal boxes at construction site till the time motors are erected and cable terminations are done. Weatherproof nickel plated brass cable glands shall be supplied loose.
- 5.22.4 In addition to packing requirements specified in EIL standard specification of motors, Vendor to do plastic wrapping for shipping from works to site.
- 5.22.5 All motors shall have provision for double earthing.
- 5.22.6 All glands supplied with motors shall be of thread type 'ET'.

#### 5.23 LOCAL CONTROL STATION

- 5.23.1 Weatherproof control stations (IP-65) for all motors, emergency stop push buttons for transformers, motors and emergency push buttons as required for plant operation and safety etc. shall be provided by the contractor.
- 5.23.2 Each motor shall have a separate push button station for motor start/stop in addition to local/remote, Auto/manual selector switch as per operation requirements. LCS for motors rated 5.5 kW and above shall be provided with ammeter.
- 5.23.3 Dual pushbutton to be provided in the transformer bay shall be wired in series and connected to the trip circuit of the upstream breaker such that pressing of both simultaneous shall trip the transformer circuit breaker. All contact of these push buttons shall be used as close permissive for the transformer circuit breaker. Additionally push buttons shall also be provided with covers and pushbutton shall be stay put type.
- 5.23.4 Each pushbutton provided in LCS shall have two elements / contacts.
- 5.23.5 Local control stations installed in outdoor area shall have GI canopy for additional weather protection.



- 5.23.6 Local control stations stop push button for transformer shall have 3 NO + 3 NC contacts instead of 2 NO + 2NC specified in EIL standard specification 6-51-0006.
- 5.23.7 Local Push Button station at each entry of substation floor shall be provided and same shall be wired to LDB for control of normal lighting of switchgear/GIS hall & cable cellar.
- 5.24 CABLING**
- 5.24.1 All HV & MV Power cables shall comply with the EIL standard specification 6-51-0051 and datasheet attached with tender.
- 5.24.2 Power cables used shall be with 3.5/ 4 cores, except for motors, which shall be 3C. The conductor size shall be minimum 4mm<sup>2</sup>. Colour of outer sheath of cables shall be BLACK.
- 5.24.3 The conductor material for MV power cables shall be copper up to 16 mm<sup>2</sup> / Aluminium above 16 mm<sup>2</sup>. However in case of cables related to DC system and UPS system all cables from Battery charger & DCDB onwards and from UPS & ACDB onwards shall be with copper conductors irrespective of cable size.
- 5.24.4 All MV control cables, plant communication cables, telephone system cables and fire alarm cables shall comply with the EIL standard specification 6-51-0052 and datasheet attached with tender. Control cables shall be 2.5 mm<sup>2</sup>, multi stranded copper conductor, twisted pair and overall shielded, XLPE insulated type. Note that type of core insulation for these cables shall be Type A as per IS 5831 and material of Inner sheath shall be ST1.
- 5.24.5 All cable tags used for cable identification shall be of stainless steel grade SS 304.
- 5.24.6 For fire alarm system, power cables shall be 2.5 mm<sup>2</sup>, copper conductor, XLPE Insulated armoured with FRLS outer sheath and cables for connecting various fire alarm devices shall be 1.5 mm<sup>2</sup>, copper conductor, twisted pair XLPE Insulated, armoured with FRLS outer sheath. Fire alarm cables shall be multi-stranded type. Colour of outer sheath of fire alarm cables shall be RED. However, power cables for fire alarm shall be BLACK in colour.
- 5.24.7 For plant communication system, 0.9 mm dia twisted pair solid copper conductor XLPE insulated cables for interconnections between MCS / OCS / FCS & exchange and 1.5 sq. mm twisted pair multi stranded copper cable for connection to the loudspeakers shall be provided. Colour of outer sheath of plant communication cables shall be GREY.
- 5.24.8 For telephone system, cable from TDJB onwards to telephone sockets shall be 660 V grade, 0.63mm dia. annealed tinned copper conductor and PVC insulated. Colour of outer sheath of telephone cables shall be GREY.
- 5.24.9 All cables shall be supplied in non-returnable steel drums.
- 5.24.10 Attached cable datasheet (B269-999-16-50-DS-0200 Rev. A) is applicable for 6.6kV cable.
- 5.24.11 FIBRE OPTIC CABLES**
- 5.24.11.1 Fibre optic cable shall be supplied along with HDPE duct.
- 5.24.11.2 The fibre-optic cable shall be of single mode type only with a minimum of 2 spare fibers in each cable. Procedure of data transmission, error control and recovery shall be as per acceptable standards.
- 5.24.11.3 All lengths shall be joint free single continuous lengths. Coating and the colour of the fiber shall not react with the surrounding jelly. Outer sheath shall be flame retardant low smoke (FRLS) type.
- 5.24.11.4 Fiber-optic data cable shall be suitable for water-submergence duty and high temperature withstand as per the routing requirements in the plant. All lengths shall be joint-free continuous lengths.
- 5.24.11.5 Optical fibers shall be coated with UV cured double acrylate resin. It should not have any reaction with cladding or core material.



- 5.24.11.6 The coatings shall be in various colours in order to facilitate fiber identification. Fiber colours shall correspond to latest revision of IEC publication 60793-2 and 60304. The colours shall correspond reasonably with standard colours and shall readily be identifiable and shall be durable. The colours should have good colour fast properties also in the presence of other materials during the lifetime of cable. The coating and the colour shall not react with the surrounding jelly.
- 5.24.11.7 The fiber optic cable shall be protected against damages from termite, rodent, fire, chemicals (such as oil & natural gas, LPG and other petroleum/ petrochemical products), moisture and water over the life time of the cable.
- 5.24.11.8 Moisture barrier – Polymer coated aluminium tape placed longitudinally over the cable core. The tape shall form a close fit around the cable core with a sealed overlap of 6mm minimum. The thickness of each polymer layer shall be 0.04 mm minimum. The thickness of fully annealed aluminium foil shall be 0.15 mm minimum.
- 5.24.11.9 The armouring of the optical fiber cable shall be of corrugated steel (electrolytically chrome plated low carbon steel) tape both side coated with ethylene acrylic copolymer, applied longitudinally with minimum overlap of 6mm. The thickness of the steel tape shall be 0.15 mm minimum. The thickness of each polymer layer shall be minimum 0.04 mm minimum.
- 5.24.11.10 The cable shall have sufficient strength to withstand a load of value  $T = 9.81 \times W$  newton, where  $W$  = mass of 1 km in kg. The load shall not produce total strain exceeding 0.25% in the fiber.
- 5.24.11.11 The termination enclosures of the optical fiber cable should be dust tight (No dust ingress) and protected against immersion in water (suitable for continuous immersion in water) and should be complete with all accessories including splice cassettes splice protection and all other accessories including accessories for electrical continuity of metallic layers of optical fiber cable and OFC preparation kit along with instruction sheet.
- 5.24.11.12 All fibres (including spare fibers) of a cable shall be terminated in the termination enclosure by pigtailed. Subsequent connection shall be by patch chords. Supply and erection of termination enclosure, pigtail, patch chord etc. is in vendor's scope. OTDR analysis/report shall form part of the testing activities of the OFC network.
- 5.24.11.13 Vendor shall furnish past track record for the selected make of the fiber optic cable, preferably for the past EIL projects during drawing review stage.
- 5.24.11.14 HDPE duct shall be permanently solid lubricated/ with spiral groove, UV-protected, fire retardant (Class V2 as per UL-94 and with limited oxygen index of 21 or higher as per ASTM D2863), of 40 mm outer diameter (+5.0/-0.0 mm) minimum thickness 3.7 mm, suitable to withstand load of 6 kg/m<sup>2</sup>.
- 5.24.11.15 All HDPE ducts shall be supplied along with accessories such as push fit coupler, bend and elbow, end plug, simple plug, sonic head, etc. required for blowing cable into HDPE duct by compressed air technology.

## 5.25 CABLING SYSTEM

- 5.25.1 Cable tray support along with cable trays inside substation cable cellars shall be provided by CONTRACTOR. Cable tray shall be provided on both side of vertical supports in multi-tier arrangement with minimum 6 cable trays uniformly spaced at 300 mm, on each vertical support along the complete length of substation. Vertical support shall be provided for complete height of cable cellar, fixed at cable cellar floor and roof. Span between two consecutive supports shall not exceed 3000 mm.
- 5.25.2 Dedicated cable route shall be provided for 220 kV & 66kV cables. Only 1 trefoil of 220 kV and 2 trefoil of 66kV cable is permitted in each tray. Sufficient space, minimum 500 mm for 220kV cables and 400mm for 66kV cable shall be provided between various tiers for laying cables. For 220 kV&66kV Cables, trays and supports shall be provided to withstand minimum 250 kg/ meter

of uniform weight for cables laid in trefoil arrangement. Sufficient space shall be provided between trays for laying of cables.

- 5.25.3 Supporting structure shall be provided for raising cable trays from cable cellar to switchgear hall for termination in GIS. Cutout provided for raising 220 kV & 66kV cables in switchgear hall for termination shall be closed by chequered plates.
- 5.25.4 Cable tray supports shall be suitable for 750 mm wide cable trays. Engineering for sizing of cable trays based on number and size of cables shall be done by CONTRACTOR.
- 5.25.5 All cable trays as required as per CONTRACTOR scope, shall be GI type with SS hardware and shall be provided by CONTRACTOR. Coupling and connection hardware of cable trays shall be of stainless steel grade SS 304.
- 5.25.6 GI pipes for cable protection above ground, floor sleeves, supports wherever necessary, cable markers, identification tags, GI saddles, saddle bars and associated accessories, all other galvanized hardware like nuts, bolts, washers, grouting bolts as necessary, shall also be provided
- 5.25.7 Modification in requirements specified above, to suit site condition shall be finalized during detail engineering, which shall be taken care by the contractor without any impact on cost and time to Owner/ EIL
- 5.25.8 Wherever trenches/trays within battery limit have interface with the trays and trenches outside battery limit, the details shall be finalized during detailed engineering. Trenches and trays shall be provided up to the battery limits as per the final approved layouts without any impact on cost and time to owner
- 5.25.9 It shall be CONTRACTOR's responsibility to co-ordinate the cable trench/ tray routing from the package battery limit area, control room and substation building etc. with other agencies involved. Trenches and trays shall be provided up to the battery limits as per the final approved layouts without any impact on cost and time to owner.
- 5.25.10 In cable trays/trenches 20% spare space shall be provided. 40% spare shall be considered in Electrical Road Crossings.
- 5.25.11 Lugs to be supplied by the CONTRACTOR shall meet the following requirements for all terminations for the equipments in the scope of CONTRACTOR.
  - Aluminum conductor cable termination on Aluminum bus bar/ terminals (like switchboards) - Aluminum lugs
  - Aluminum conductor cable termination on Copper bus bar/ terminals (like motor) - Bimetallic lugs having Al barrel & tinned Cu palm
  - Copper conductor cable termination on Aluminum bus bar - Bimetallic lugs having tinned Cu barrel & Al palm
  - Copper conductor cable termination on copper bus bar/ terminals - Tinned copper lugs.
  - Lugs provided for termination of HV & MV cables at switchgear end shall be of long barrel type.
- 5.25.12 Glands to be supplied by the CONTRACTOR shall be of nickel-plated brass for all cabling & termination for the equipment in the scope of CONTRACTOR. The cable glands shall be single compression type for indoor equipments & double compression type for outdoor equipments.
- 5.25.13 MV Control cable shall be of Multi-stranded conductor, twisted pair individual & overall shielded, XLPE insulated type.
- 5.25.14 The Cable outer sheath Color for various twisted pair cables shall be as follows:

|                   |                  |
|-------------------|------------------|
| MV Control Cables | Black base color |
|-------------------|------------------|

|                         |                  |
|-------------------------|------------------|
| MV Communication Cables | Gray base color  |
| MV Fire Alarm Cables    | Red base color   |
| MV Fire Safe Cables     | White base color |

## 5.26 EARTHING AND LIGHTNING PROTECTION

- 5.26.1 Earthing system of the entire package shall be designed to meet the statutory requirements and shall be included in contractor's scope including interconnection with owner's earth grid and earthing of all equipment.
- 5.26.2 Earth Resistivity Value shall be measured by CONTRACTOR at minimum five locations before earthing system design calculation.
- 5.26.3 Contractor shall measure the earth resistivity of soil as per Wenner's four electrode method. For determining the earth resistivity, five test locations shall be chosen to cover the whole site as per the site-Engineer-in-charge. This number shall be increased if the test results obtained shows a significant difference. The tests shall be conducted during the dry season
- 5.26.4 Earthing system shall conform to following standards:
  - 5.26.4.1 IEEE-80 Guide for safety in AC substation grounding.
  - 5.26.4.2 IS-3043, Code of practice for earthing.
  - 5.26.4.3 CBIP Tech. report for Earthing System for HV, EHV and UHV Substations.
  - 5.26.4.4 CEA Regulations as amended from time to time and the relevant regulations of the Electricity Supply Authority concerned.
  - 5.26.4.5 The earthing work shall also conform to EIL specification for Installation of earthing system.
- 5.26.5 Lightning protection shall comply with the requirements of IS/ IEC 62305. Contractor to furnish calculation for lightning protection of building. Lightning protection of building and switchyard area shall be separate and shall be designed for LPS 2 as a minimum. Lightning strip size shall be minimum 25 x 3 mm.
- 5.26.6 Cross-section of earthing conductor shall be designed to prevent fusing of conductor and deterioration of joint under most adverse conditions of fault. The same shall be determined as per IS: 3043, and to meet the regulations of CEA Regulations. MS rod shall be used for the buried earth grid in outdoor switchyard. For earthing conductor sizing, duration of earth fault current duration to be considered, shall be minimum one second.
- 5.26.7 The entire installation shall be done in accordance with standards mentioned herein. The contractor shall carry out any changes desired by the electrical inspector or the owner, in order to make the installation conform to CEA Regulations at no extra cost.
- 5.26.8 Earthing system shall be designed to have a low impedance to ground and a current carrying capacity consistent with the fault current. The earth loop impedance to ground shall not be in excess of 1.0  $\Omega$ . The main earth loop shall be laid at a depth of minimum 500 mm below grade level. Earth resistance of individual electrode to general mass of earth shall not exceed requirements given in OISD-STD-137.
- 5.26.9 Test disconnect facilities shall be provided for the earth pits to check their earth resistance periodically.
- 5.26.10 The method of earthing has to be considered from the view point of touch and step potentials in the area extended 1 meter outside the substation battery limit and in outdoor switchyard area, so as to ensure that the area in the vicinity of the substation and the switchyard equipments is safe from the viewpoint of touch potential under fault conditions.
- 5.26.11 The attainable and permissible values of the step and touch potential in the design of the earthing grid in substation shall be calculated as per IEEE 80, and it shall be ensured that the

attainable step and touch potential are less than permissible step and touch potential. For step and touch potential, current distribution factor shall be considered as 1 and duration of rated fault current shall be 1 second.

- 5.26.12 Contractor shall provide earth grid up to battery limit of the package including provision of earth plate near the battery limit for interconnection of the unit earth grid with the Owner's main plant grid. CONTRACTOR shall extend & connect the plant earthing grid to main earthing grid, at minimum two points.
- 5.26.13 All earthing hardware (i.e. nut, bolts, etc.) for earth pits, earth plate connection cable trays earthing, etc. shall be of stainless steel grade SS 304.
- 5.26.14 Contractor to note that separate dedicated earth electrodes shall be provided for lightning protection.
- 5.26.15 **Equipotential Earth mat.**
- 5.26.15.1 When a fault current flows through the earthing connections into the soil, the enclosures, linked to the earthing circuits, will be at the same potential as the earthing mat conductors but this potential is generally different from that on the soil surface.
- 5.26.15.2 In order to ensure the security of personnel, it is necessary to install an equipotential mat linked to the general earthing mat in the zones where metal enclosures and fixed accessories are accessible from the floor.
- 5.26.15.3 It is also necessary to provide an equipotential earthing mat in the zones where an emergency mechanical operation or a locking system is accessible from the floor. It is therefore possible to extend the equipotential mat to allow the operator to carry out his maneuvers.
- 5.26.15.4 In order to ensure a good equipotential surface, each element of the equipotential mat must be connected to the general earthing network by the manufacturer.
- 5.26.15.5 This mat will be placed on the floor, all around the switchgears. It is not required in front of the control cubicles.
- 5.26.15.6 If it is an oxidizing material, it should be hot dip galvanized.
- 5.26.15.7 The manufacturer must design, specify, and provide this equipotential earth mat. The location of the equipotential mat should be defined by the supplier for all the GIS and at places where:
- The enclosures are accessible for the floor.
  - Manual operation of apparatus or locking system is located.
- 5.26.15.8 Equipotential earth mat drawings along with design calculations shall be submitted for approval by the CONTRACTOR along with general arrangement drawings.
- 5.26.16 All earth pits for earthing and lightning protection shall be maintenance free chemical earth pit with Cu bonded high tensile low carbon steel core electrode.
- 5.26.17 Earth connections shall be welded at joints, anti-corrosive paint or bitumen and jute covering shall be applied for welded portion.
- 5.26.18 Separate clean earth system shall be provided for Numerical relays, SAS & ECS in Substation.
- 5.26.19 Material of connection of equipments to earth plate shall be as per the equipment earthing schedule enclosed with the tender document.
- 5.26.20 Minimum size of the main earth grid shall be 100 x 12 for Substation. However, Earthing sizing calculation shall be furnished by Contractor for the final GI earth strip selected.
- 5.26.21 Adequate number of earth plates for taking branch connections shall be provided.

## 5.27 **LIGHTING SYSTEM**

- 5.27.1 Normal lighting, Emergency lighting and DC Critical lighting shall be provided as per Electrical Design Philosophy.
- 5.27.2 All lighting fixtures shall be LED type, supplied complete with associated LED lamp and driver
- 5.27.3 25% of total fixtures shall be fed from emergency lighting panel for illumination, in case of failure of normal power supply.
- 5.27.4 During normal operation, both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency power supply source. Critical (DC) lighting shall be normally kept 'OFF' and during failure of AC power; DC system shall feed the critical lighting system.
- 5.27.5 All lighting fixtures shall be suitable for the area in which they are installed. All hardware of the lighting fixtures like nuts, bolts, mounting brackets for ceiling & column mounting and adaptors for installation on poles shall be with MOC of SS304.
- 5.27.6 For fixture mounted on pole dedicated standalone junction box shall be provided at bottom for loop-in loop-out.
- 5.27.7 Lighting & Power panels shall be standardized to have 6, 12 or 18 single phase outgoing feeders. The panel shall be provided with 30% spare out goings
- 5.27.8 All lighting poles shall be hot dipped galvanized type with SS hardware.
- 5.27.9 DC critical lighting shall be provided at exit, escape route inside the building/plant area and other strategic locations in package battery limit.
- 5.27.10 All lighting fixtures shall also have independent earth terminal outside the enclosure.
- 5.27.11 Cable from lighting panel onwards to the outdoor lighting fixtures shall be 3Cx2.5mm<sup>2</sup>, Copper conductor, and armored FRLS cable.
- 5.27.12 It is vendor's responsibility to ensure that adequate lighting is maintained within package battery limit with minimum lux level specified as per clause 7.4.12 of 6-51-0099. The same will be measured and demonstrated at site. In case additional lighting fixtures and associated circuit/cabling is required, the same will be provided by vendor without any time/cost implication to owner.
- 5.27.13 415/ 415V Dry type lighting transformer shall be supplied with vector group as Dyn1

## 5.28 SPECIAL REQUIREMENTS FOR LEDs FIXTURES

### 5.28.1 TECHNICAL REQUIREMENTS OF LED:

- 5.28.1.1 LED efficacy shall be greater than > 140Lumen/Watt @ 350mA drive current. In respect of LEDs of higher power ratings, drive current greater than 350mA can be accepted if the LED's LM 80 / IS: 16105 test reports support the same.
- 5.28.1.2 LED type shall be SMD (surface mounted device) type LED for all applications. COB type to be considered only for applications such as High bays, Flood Lights & Flameproof Light Fittings.
- 5.28.1.3 Approved makes for different LED technology/types shall be as follows:

| LED Technology/ Type           | Approved Make                                                                                   |
|--------------------------------|-------------------------------------------------------------------------------------------------|
| SMD                            | Nichia, Osram, Lumileds (Erstwhile Philips Lumileds), CREE                                      |
| C.O.B                          | Citizen, Bridgelux                                                                              |
| Domestic/Decorative Luminaires | Everlight Taiwan, Edison Taiwan, Samsung Korea, Osram Germany along with makes approved for SMD |



- 5.28.1.4 Test Report for Ambient Temperature of 55 / 85 / 105 °C at rated and maximum current shall be submitted for SMD type LED. For COB type LED, as soldering temperature is not applicable for COB technology, LM 80 test report shall be submitted.
- 5.28.1.5 TM 21 life projection calculations along with LM80 for all three ambient temperature of 55 / 85 / 105°C as per applicable standard shall be submitted to substantiate that life of LED Chip shall be more than 50000 Hrs for both commercial and Industrial range and 25000 Hrs for LED Bulb, domestic and decorative Range.
- 5.28.1.6 Reported life Span of LEDs used in the Luminaire shall be greater than 50,000 Hrs at the soldering point temperature of 85°C and at the luminaire driving current.
- 5.28.1.7 The LEDs shall comply with Photobiological Safety norms as per IEC 62471 / EN62471 / IS: 16108 and should fall in the exempt group for indoor luminaires and in exempt or low risk group for outdoor LED luminaires.
- 5.28.1.8 View angle : Typical 120°
- 5.28.1.9 The colour temperature of the proposed white colour LED shall be from 5700K (i.e. 5665K±355K) to 6500K for indoor type luminaire Step 5 or Step 3 McAdam ,as per ANSI standard C78.377A, & 5700K (i.e. 5665K±355K). For outdoor type luminaires, Step 7 McAdam, as per ANSI standard C78.377A, will be accepted on account of colour consistency.
- 5.28.1.10 The Colour Rendering Index (CRI): CRI should include all colour range from R1 to R15, shall be > 80 for Indoor luminaire and > 70 for Outdoor luminaire.

#### 5.28.2 TECHNICAL REQUIREMENTS FOR LED DRIVER

- 5.28.2.1 Min. efficiency of driver: The minimum efficiency of LED driver shall be 85% for driver power output rating ≤40W and 87% for driver power output rating > 40W.
- 5.28.2.2 Power factor of complete fitting shall be greater than 0.90.
- 5.28.2.3 In-built high voltage cutoff shall be ≥ 290Volt.
- 5.28.2.4 Driver Surge Protection standard: Surge Protection for minimum 2kV for indoor and minimum 3kV for Outdoor LED systems shall be provided. However, if a site is prone to lightning and surge, 10kV surge protection shall be required. In case of outdoor luminaires, the Surge Protection Device (SPD) should be series type with fail safe.
- 5.28.2.5 Total Harmonic Distortion (THD): Less than 10 % for full load for more than 20 W and less than 20% for less than 20W. Not applicable for Domestic/Decorative LED fixtures.
- 5.28.2.6 Isolated driver shall be used. Short circuit protection /Open load protection shall be provided
- 5.28.2.7 For driver power output rating > 50W, potted driver shall be provided.
- 5.28.2.8 The power supply shall be connected to the LED PCBs through proper connectors.
- 5.28.2.9 EMI/ EMC compliance: The driver shall comply to the following EMI/ EMC standards:
  - CISPR 15/ 18:6873 (CE, RE, CDN) or compliance to equivalent EN standard.
  - IEC: 61347 (reference standards are listed as follows)
- 5.28.2.10 Driver shall comply with the safety requirements laid down in IEC: 61347 - 2 - 13/ EN: 61347 - 2 - 13/ IS: 15885 - 2 - 13.

#### 5.28.3 TECHNICAL REQUIREMENTS OF ELECTRONIC COMPONENTS USED IN LED LUMINAIRE

The circuit boards and electronic components to be used in the luminaire should be of rating/ type so as to provide reliable functioning. Following shall be ensured during procurement:

- 5.28.3.1 MCPCB is to be used for SMD technology for LED wattage in excess of 0.5. The minimum thickness should be 1.0 mm for indoor and 1.6 mm for outdoor type luminaire. However, the same is not applicable for COB.



5.28.3.2 FR4 grade PCBs of min. thickness of 1.6 mm shall be used in driver circuits. The same is not applicable for COB.

#### 5.28.4 TECHNICAL REQUIREMENTS OF LED LUMINAIRE

5.28.4.1 The luminaire shall have LM-79 / IS: 16106 test report from a NABL accredited laboratory.

5.28.4.2 The min. system lumen efficacy of the luminaire shall be 95 lm/W (for luminaire system wattage  $\leq 15$ W) and 100lm/W for wattage  $> 15$  W.

5.28.4.3 Following shall be required in terms of secondary lens/ optics:

- Outdoor industrial luminaire like well glass, flat glass may not have secondary lens/optics.
- For other Industrial and outdoor fixtures, luminaire must have secondary lens/optics of type PMMA/Borosilicate glass/Polycarbonate.

5.28.4.4 Color temperature: 5700K (5665 $\pm$ 355K, as per ANSI standard C78.377A )

5.28.4.5 Housing of luminaire: Housing of outdoor and/or FLP shall be Pressure die-cast LM6/ADC12/LM24. For indoor, non-weather proof items like CRCAIPC/Aluminium Extrusion housing can be used.

5.28.4.6 Cover type: For outdoor type fittings, cover type shall be Toughened glass or UV stabilized polycarbonate whereas, for indoor and non-weather proof items, UV stabilized Poly Carbonate can be used.

5.28.4.7 Minimum Ingress Protection Required for LED Flood Light / Outdoor Industrial is IP 65.

5.28.4.8 Impact Resistance: For outdoor fittings minimum impact resistance shall be IK-05 and not applicable for indoor fixtures.

5.28.4.9 Temperature rise test: When the luminaire has stabilized thermally, soldering point temperature shall be  $\leq 85$  °C for SMO type but for COB type the temperature rise test shall not be applicable.

5.28.4.10 Temperature rise (above ambient) of heat sink should generally remain within 20°C - relaxation on this account can be granted as long as the soldering point temperature limit of 85°C is not violated and there is no unacceptable outcome.

5.28.4.11 BIS Registration: The luminaire shall have BIS approval for surface mounted luminaire as applicable.

5.28.4.12 Flameproof tight fittings shall be certified for use in hazardous area as per area classification and the flameproof certificate shall be submitted by the vendor. Explosion proof certificate from PESO shall be submitted before or along with supply of such light fittings.

#### 5.28.5 TESTING OF LED LUMINAIRE

5.28.5.1 Following acceptance tests shall be carried out / type test & routine test certificates from NABL accredited Labs shall be provided as per relevant standards.

- Visual and dimensional checks
- Resistance to humidity test
- Insulation resistance (IR) test
- High Voltage test
- Over-voltage protection
- Surge protection
- Total harmonic distortion (THD) test
- Reverse polarity test
- Temperature rise test

- Ingress protection test

5.28.5.2 Type test report/ certificate as per relevant standards on selected sample including endurance test as per IS10322 & Safety test for Drivers as per IS15885 from NABL accredited lab shall be submitted.

#### 5.28.6 MISCELLANEOUS REQUIREMENTS

5.28.6.1 For LED fixture, integral junction box shall be provided with 3 nos. cable entries for loop-in, loop-out and associated wiring to fixture. Alternatively 2 nos. cable entries for loop-in and loop-out shall be provided with internal wiring for driver and lamp.

5.28.6.2 All lighting fixtures shall be supplied complete with associated LED lamp and driver.

5.28.6.3 All lighting fixtures shall be supplied with fixture mounting nuts and bolts of stainless steel SS-304. Fixture mounting bolts & nuts for mounting the light fittings on already installed clamps/brackets. However, Clamps/brackets mounting bolts & nuts are excluded from vendor's scope.

5.28.6.4 Flameproof LED type lighting fixtures shall fulfill the following requirements:

- LED lamps and Drivers shall be provided with min. 5 years warranty period.
- Lighting fixtures reserved for use in 240 Volt AC Emergency Circuit shall have additional RED Circular ring marking for identification purpose for hazardous area identification. This detail shall be furnished to successful vendor during detailed engineering.
- Vendor shall indicate the following parameters as a minimum in fixture drawings:
  - Fixture Wattage and LED Wattage
  - Actual Consumption of Fixture
  - Driver Consumption
  - Fixture Life time
  - Luminous Efficacy of fixture
  - Lumen Output of Fixture
  - Tolerance for Voltage and wattage rating
  - Power factor of Fixture
  - Beam Angle of Lighting Fixture
  - Weight of Fixture
  - LED LAMP and Driver Warranty Period
  - Driver Surge Protection
  - Compliance to IEC-61347-2-13 for LED Driver
  - BIS Certification no. for Driver
  - Driver Make and Model No.
  - LED Make and Model no.
  - LED type i.e. COB (Chip on Board) or Multichip etc.
  - Quantity of Fixtures
  - No. of Cable entries for Fixture along with quantity of FLP Cable glands and FLP Stopper plug.
  - PESO/CIMFR/BIS License certificates numbers along with dates.
- IES files of all LED lighting fixtures finalized during detail engineering shall be furnished for owner/EIL records.

#### 5.29 FIXED TYPE SPACE HEATER PDB

5.29.1 PDB shall be installed in safe area and shall be suitable for safe area. Ingress protection shall be IP-41.

- 5.29.2 PDB shall be single front, and fixed type, free standing floor mounted type. PDB shall be minimum 415V, 200 Amp, 50Hz, TPN, 25 kA (1 sec.) with two number SFU incomers mechanically interlocked with each other.
- 5.29.3 The switchboard shall be non-compartmentalized type instead of compartmentalized specified in 6-51-0012. However, other requirements of 6-51-0012 shall be complied with.
- 5.29.4 The number of outgoing 240V AC, SPN feeders in the PDB for Owner's use shall be as follows:

| Rating              | Nos |
|---------------------|-----|
| 16A Double Pole MCB | 6   |
| 32A Double Pole MCB | 6   |
| 63A Double Pole MCB | 6   |

- 5.29.5 Incomer feeder shall be provided with voltmeter and ammeter. All indicating lamps shall be LED type.
- 5.29.6 Terminals for outgoing feeder's upto 16A shall be suitable for 10 Sq.mm. cable. Terminals for upto 32A and 63A feeders shall be suitable for 25 mm<sup>2</sup> cable. Supply of lugs and nickel-plated brass cable glands for all cabling & termination in the scope of vendor inclusive of cable glands for incoming cable to PDB. The cable glands shall be single compression type.

#### 5.30 SOLAR ROOFTOP PHOTO VOLTAIC SYSTEM

- 5.30.1 Contractor shall provide grid connected solar power plant units at roof top of main substation MRSS-100 in P25 area on substation switchgear room and transformer bays and feed the generated solar power to the electrical system of the complex. The solar power shall be generated at 415V, TPN, 50 Hz which can support loads at 0.8 pf.
- 5.30.2 The scope of work for contractor includes design, manufacture, supply, erection, testing and commissioning of grid connect interactive solar PV power plants without batteries on substation building roof. Solar power unit shall be connected to the nearest 415V MV switchboard for export of solar power. The solar power systems shall remain synchronized with the grid supply for generation of solar power.
- 5.30.3 Each photovoltaic solar panel shall be divided into small sub arrays to feed into Power Conditioning Units (PCU). The series parallel connection of sub arrays shall be done through panel junction boxes, Array junction boxes and main junction boxes. The AC output of the PCUs shall be collected at the MV switchboard. The detailed scheme for power evacuation shall be worked out by the contractor.
- 5.30.4 PV panels shall be installed on the complete building terrace area which includes roof top of substation switchgear room and transformer & capacitor bays except for personnel movement area and area for other facilities installed on the roof top. Minimum 1 KWp solar panels shall be located in each 12 m<sup>2</sup> area.
- 5.30.5 The minimum guaranteed supply of energy from the solar power systems shall be 1400 KWh/year for 1 KWp PV panel. The contractor/manufacturer shall furnish the undertaking for guaranteed supply of energy for the solar power systems provided by them.
- 5.30.6 Contractor shall engage the services of a separate specialist agency/manufacturer for execution of solar power plants including design, engineering, sizing, selection & procurement of equipment/material, installation, testing and commissioning of solar power plants. The agency shall be an established manufacturer/supplier of complete SPV power system and shall have adequate experience for carrying out similar SPV based solar power plants. The agency should have designed, supplied, installed and commissioned SPV power plants of cumulative installed capacity of 250 kWp or above, out of which at least one plant should be of 100 kWp capacity

operating satisfactorily for more than one year. The agency shall be approved by PMC/Owner during detail engineering based on details furnished by contractor.

- 5.30.7 The PV solar panels shall be located on roof tops of substation switchgear room and transformer & capacitor bays away from the shadow area. The direction of solar panels shall be as per manufacturer recommendation. The PCU shall be located within the building in Air conditioned room.
- 5.30.8 Complete cabling including supply, laying and termination of cables, cable trays, material, hardware etc. within SPV power plant units and from power plant units to MV switchboards for export of solar power is in contractor scope.
- 5.30.9 For further requirements/details refer Specification for Solar PV System attached with the tender.

#### **5.31 REQUIREMENT FOR AIR CONDITIONING**

- 5.31.1 Vendor scope shall include sizing, design, engineering, manufacturing, supply, installation, testing and commissioning, packing and delivery at site of all the electrical equipments including supply of all commissioning spares, special tools and tackles as per the specifications and the datasheets attached or referred. The major electrical equipments for the package includes
  - 5.31.1.1 All MV motors
  - 5.31.1.2 Power distribution board - PDB (As per EIL specification 6-51-0012) for all motors and other load of the package, separate for each building (PDB shall be installed in AC Plant/ Package room, AHU room, as required).
  - 5.31.1.3 Supply, laying and termination of all power and control cabling for all package loads.
  - 5.31.1.4 Cable trays, as required for laying the cables for the motors/ loads.
  - 5.31.1.5 Local control panels/ local push button stations (as required).
  - 5.31.1.6 Earthing material as required for earthing for package equipments.
  - 5.31.1.7 Any other equipment not specifically mentioned above but required for normal operation of the package equipments.
- 5.31.2 PDB shall be single front, compartmentalized, and fixed type. PDB shall be suitable for 415V, 50Hz, TPN, 50 kA (1 sec.) with single bus, two SFU incomers (4 Pole) provided with manual transfer facility and mechanical interlocking between incomers.
- 5.31.3 The number of feeders in the PDB shall be as per the electrical loads of the respective building, where PDB is located. PDB for AC Plant room in shall also include feeders for downstream PDBs located in each AHU Room
- 5.31.4 All PDBs shall be suitable for TOP Cable entry. Minimum clear space of 1000mm shall be maintained in front of PDBs.
- 5.31.5 Incomer feeder shall be provided with voltmeter and ammeter. Incomer SFU shall be 4 Pole type. All motor& other feeders shall be provided with hardware as per the respective datasheets for same attached with the tender, however same shall be in fixed execution. Field ammeter shall be provided in LCS for motors above 55 kW.
- 5.31.6 Providing required interlocking between main PDB & sub PDB of A/C system of a particular building shall be in vendor scope.
- 5.31.7 For Air-conditioning, all blowers shall trip and all "Fire Dampers" shall automatically close on receipt of "Fail-safe FIRE signal" i.e. normally closed but open on Fire condition contact. CONTRACTOR shall take care of this contact in fire alarm system of building. Further distribution of fire signal to each vendor's sub PDB in AHU room (for air-conditioning system) shall be in vendor's scope.

- 5.31.8 All indicating lamps shall be LED type. LED for Space heater 'ON' indication shall be provided for all feeders.
- 5.31.9 20% spare outgoing feeder or minimum one of each type, whichever is higher shall be provided for each PDB
- 5.31.10 Control transformer shall be provided for each outgoing feeder module.
- 5.31.11 Required number of earth plate shall be provided within AC room, AHU room, and pressurization room. Further connection of individual equipments with earthing system shall be done by contractor. For earthing of various equipments upto earth plate, earthing schedule attached with the tender shall be followed
- 5.31.12 All the Electrical work of this package shall be carried-out as per EIL Standard Spec no. 6-51-0093 for package units.
- 5.31.13 Co-ordination required for lighting and fire alarm installation works for areas with false ceiling and/ or air-conditioning ducts is in scope of vendor.

#### **5.32 REQUIREMENT FOR EOT CRANE**

- 5.32.1 One EOT Crane for GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements & lifting assemblies for erection & maintenance of GIS equipment.
- 5.32.2 The capacity of the crane shall be sized to lift the heaviest GIS switchgear component.
- 5.32.3 The Crane shall be used for the erection and maintenance of the GIS switchgear component and all parts installed in the GIS switchgear room. On completion of erection of the switchgear, the CONTRACTOR shall completely service the crane before the handing over to client.
- 5.32.4 For detailed specifications of EOT crane, refer elsewhere in the tender document.

#### **5.33 FIRE PROOFING SYSTEM**

- 5.33.1 The fire-proof sealing system and fire protection coating system are required to prevent the spreading of fire from one place to another (or one zone to another) through the openings in wall / floor, along cables laid in trays / racks and through openings below floor-mounted Electrical Switchgear, MCC, Distribution Boards, Junction boxes, Cabinets and Panels. The systems shall be installed in the specified locations in consultation with the purchaser's engineer after all cables have been laid and terminated.
- 5.33.2 For further requirements/details refer Specification for Fire Proof Sealing System attached with the tender.

#### **5.34 SYNCHRONISATION, CONTROL AND ANNUNCIATION PANEL (SCAP)**

- 5.34.1 For the 220kV system covered under the scope of this tender hard wired control, metering and annunciation shall be provided on SCAP which shall be located in Main Substation MRSS-100 in P25 Area and same shall be of mosaic panel type. SCAP shall carry out the control, monitoring and annunciation functions including those of future incomers, which shall include but not be limited to the following
  - 5.34.1.1 Control functions
    - Control of all breakers (incomers, bus couplers, outgoing).
    - Tap changer control of Grid transformers
    - Auto/Manual synchronization of all incomers and bus couplers.
    - ON/OFF control of all incomers, outgoing feeders and bus couplers including outdoor IBPs in outdoor switchyard.
    - Manual Synchronization subsystem complete with running and incoming voltmeters, frequency meters, ON/OFF switch, check synchronizing and guard relays, switches, lamps and any other hardware as required.

- Manual Changeover of incomers & bus couplers.

#### 5.34.1.2 Monitoring functions

- Voltage of incomers and buses.
- Current of each phase of incomers and bus couplers/section breakers
- Frequency of each incomer
- Power factor of each incomer
- MW, MVAR & MVA of each incomer and outgoing feeder.
- MWH, MVARH of each incomer
- Voltage and frequency recorder for each bus.
- Any other function, which is not mentioned but is essential for operation and safety of equipment and personnel.

#### 5.34.1.3 Audio-visual annunciation Functions

Audio-visual annunciation shall be provided for monitoring the equipment, transformers, switchboard and other electrical equipment as a minimum, but shall not be limited to the following:

- Annunciation of Fault status of Breakers
- Operating and fault status of all protective relays and trip alarm of incomers, buscouplers, etc.
- Complete trip and non-trip alarm annunciation for all transformers including alarm of OLTC.
- Annunciation of all protective relays and trip alarms of all major electrical equipment in the substation
- Hooter and clock.

#### 5.34.1.4 Status on mimic diagram

- ON/OFF/TRIP indications of all breakers
- Semaphore indicators for all circuit breakers, isolators and earth switches

#### 5.34.1.5 Control And Operation Philosophy

- Switchboard shall have one local/remote control selector switch. When the switch is selected in local mode, the control will be done from GIS control cubicle.
  - It shall be possible to close any incomer and bus coupler/section breaker of GIS in test condition.
  - It shall be possible to close any of the outgoing breakers of GIS in service condition.
  - When selector switch is selected in remote mode, control shall be transferred to hard wired synchronizing panel (SCAP).
- Hard wired synchronizing panel (SCAP) shall be provided with the following selector switches for operation and control:
  - SW-1    3-position selector switch (SCAP/ OFF/ECS)
  - SW-2    4 position selector switches for each breaker to be synchronised (OFF/Dead bus/Manual synchronizing/Auto synchronizing)
  - Incomers selector switches shall be provided on SCAP for selecting the incomers to be sync checked and closed.
  - Contractor, based on the requirements of synchronizing scheme finalized shall decide quantities of these selector switches.



- Following operations shall be possible from SCAP:
  - Closing of all incomer breakers (in service position) and bus couplers/section breakers (in service position) on dead bus condition (bus coupler/ section breakers dead bus closing to be checked on either side).
  - Synchronizing and closing of selected incomer breakers (in service position) and bus couplers/ section breakers (in service position) through check synchronizing & auto synchroniser.
- Required interlocks for safe operation shall be provided.

### 5.35 ECS INTERFACE

- 5.35.1 All signals as per ECS IO List sheet attached elsewhere shall be provided in respective equipment for interface with the Electrical control system.
- 5.35.2 Number of analogue / digital IOs for ECS interface shall be worked out by the CONTRACTOR as per the ECS I/Os list attached.
- 5.35.3 CONTRACTOR to note that:
- 5.35.3.1 Acquisition of input/output (I/O) signals as hardwired or software:
- All numerical relays shall be connected to a substation automation system. ECS shall communicate with the substation automation system to acquire relay and metering status I/O signals of the relays. These I/O signals have been indicated as "relay and metering LAN" in the typical I/O list.
  - All other I/Os shall be acquired hardwired and have been indicated as "hardwired" in the typical I/O list.
  - In case any of these data cannot be acquired over the relay LAN, these signals have to be provided as hardwired. For requirement of numerical relays, refer Electrical part of contract document.
- 5.35.3.2 The I/O list is indicative only. Any other I/O required to meet the contract requirements shall be identified and provided by CONTRACTOR
- 5.35.3.3 Guidelines for ECS I/O Interface Design

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Analogue Input Signals | Signal transducers for hard-wired analogue inputs shall have accuracy class 0.1 for the range 0-120%. All transducers shall be externally-powered types. External power supply shall be 230V AC UPS.<br><br>For all measurements for I, V, MW, MVAR, Hz, obtained on the relay and metering LAN, maximum possible accuracy shall be ensured                                                                                                                                                                                                                                                                                                                                                     |
| Digital Input Signals  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Alarm (D)              | Alarm is a signal which requires operator to be alerted such as VT circuit MCB (closed, open), relays 86 & 95 (operated, reset), auto-changeover (blocked, not blocked), DC control supply (healthy, failed), line voltage (unhealthy, healthy), bus voltage (unhealthy, healthy), motor trip from process, under-voltage trip. This shall be hardwired / on relay LAN as specified.<br><br>For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) preferred. CONTRACTOR shall specifically indicate if NC contact is being provided in place of NO contact.<br><br>Generally a hardwired alarm point is put under "sequence of event" monitoring |
| Status (S)             | For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) required                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

#### Digital Output Signals

##### Command (C)

Hardwired through potential free changeover type contact of interposing relay, contact rating 5 A, 240 V AC and/or 4 A, 110V DC. Coil rating shall be 24 V DC

## 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 software. Contractor shall furnish the native file of ETAP after carrying out the preliminary study (stage-1), intermediate study (stage-2) & final study (stage-3). Following study shall be done by contractor & report shall be submitted to EIL/owner for review/approval:
- Load flow
  - Short circuit
  - Motor startup studies (Largest HV and MV motor shall be intimated during detail engineering.
  - Transient stability
  - Harmonic study
  - Relay co-ordination
  - Insulation co-ordination (\*)
  - Transformer inrush current (\*)
- (\*) If the study is not part of ETAP, contractor shall utilize other reputed industry proven software to conduct these studies. Operating & contingency conditions for carrying out power system study shall be informed during detailed engineering.
- 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.
- 6.13 All Emergency Stop/Stop pushbuttons on LCS/LCP/Switchboard shall be provided with protective covers to avoid accidental operation.
- 6.14 Contractor shall include painting and marking of all buses, individual incomers, all outgoing feeders etc. with detail such as Tag no., feeder rating, sending end source reference etc. for all switchboards.
- 6.15 All switchboards, panels, etc. shall be provided with LED indications and adequate no. of LEDs shall be provided to give required illumination.
- 6.16 All ACB fed motor feeders (>55kW), schematics shall have provision for auto start and auto re-acceleration with feature to inhibit irrespective of process/licensor's requirement. Reacceleration scheme for contactor fed motors (<=55kW) shall be provided by Contractor for all those drives requiring reacceleration as per Process requirements.
- 6.17 For owner supplied items, feeders at 415V/230V AC/ 110V DC/ 230V AC UPS voltage shall be provided by the contractor in the respective switchboard supplied by them. The details for same shall be provided during detailed engineering.
- 6.18 All the critical inputs must be wired in SAS/ECS for proper monitoring.
- 6.19 Armoured cables with double compression glands shall be used inside Battery Rooms along with FLP fittings/equipments.
- 6.20 Contractor / vendor shall comply with the requirements as per Ministry of Power (GoI)'s various orders regarding testing of all equipment, components & parts imported for use in the power supply system for cyber security to check for any kind of embedded malware/Trojans/cyber threat and for adherence to Indian Standards. Necessary testing of their equipment/ components at designated labs & obtaining test certificates in line with MOP orders shall be done by contractor/vendor
- 6.21 Color of HDPE duct for various application shall be as under :

| Sr. No. | Application                                            | Colour                                                                                           |
|---------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1.      | Fire Alarm System Data highway<br>OFC cables           | Fire Red                                                                                         |
| 2.      | Substation Automation system                           | Black with blue strips                                                                           |
| 3.      | ECS System OFC Cables                                  | Black with red strip for main data highway.<br>Black with blue strip for redundant data highway. |
| 4.      | HDPE conduit for LAN line OFC                          | YELLOW conduit with BLACK strip                                                                  |
| 5.      | HDPE conduit for Feeder differential protection System | GREEN conduit with WHITE strip                                                                   |

6.22 **ADDITIONS / DELETIONS / MODIFICATIONS TO STANDARD SPECIFICATION**

6.22.1 Specification for Earthing Installation (6-51-0084 Rev.4)

6.22.1.1 The last sentence of clause no.5.1 of 6-51-0084 stands modified as below:

"The Earth electrodes shall be so located such that inter distance/ mutual separation between two electrodes shall not be less than twice the driven depth, however in areas where there is physical limitation to meet the above separation, the mutual spacing can be reduced to a value not less than the driven depth of each electrode".

6.22.2 Specification for Medium and High Voltage cables & accessories (6-51-0051 Rev.8)

6.22.2.1 Clause No. 5.1.6 (b) shall be read as below:

"Temperature index as per ASTM-D-2863 i.e. to determine at what temperature normal oxygen content of 21% in air will support combustion of FRLS sheath will remain as 250°C".

6.22.2.2 Refer Cl. 6.3.1 and note that standard cable drum lengths for below mentioned cable sizes stands revised as mentioned below:

- Multi core power cables up to 50 sq.mm. – 2000 m
- Control cable of size up to 7x2.5 sq.mm. – 2000 m

6.22.2.3 The following point is added at the end of specification:

"For screen sizing calculations, final temperature to be considered shall be 200 °C under adiabatic conditions".

6.22.3 Specification for Communication and Fire Alarm Cables (6-51-0052 Rev. 6)

The following clauses of 6-51-0052 stands modified as below:

6.22.3.1 Cl. 4.3.2 – For XLPE insulated PA/FA/Telephone/Paired Control Cables, insulation thickness (nominal values) shall be as per IS-7098 (Part-1).

6.22.3.2 Cl. No. 6.3 (d) - Temperature index as per ASTM-D-2863 i.e. to determine at what temperature normal oxygen content of 21% in air will support combustion of FRLS sheath shall remain as 250°C.

6.22.3.3 Cl. No. 7.3 – Standard cable drum lengths for below mentioned cable sizes stands revised as mentioned below:

- PA/FA/Signal cable having size up to 6 pair 1.5 & 2.5 sq.mm. – 2000 m
- PA/FA/Signal cable having size up to 10 pair 0.9 mm dia. – 2000 m

6.22.4 Specification for Uninterrupted Power Supply System (6-51-0017 Rev. 7)

6.22.4.1 The following is added at the end of Cl. No. 5.3.9 of specification:

"The efficiency of DC-DC Converter / Buck Boost Amplifier shall be considered in battery sizing calculations as well as rectifier sizing calculations and capacity of battery and rectifier shall be accordingly sized".

6.22.5 Specification for Battery Charger (6-51-0019 Rev. 6)

6.22.5.1 The following is added at the end of Note-2 on Page 13 & 14 of specification:

"Battery isolator (MCCB/Switch Fuse) shall be provided with three pole version to ensure positive isolation of all the three connections of battery".

6.22.6 Electrical Installation Standards 7-51-0201 Rev. 5, 7-51-0202 Rev. 5, 7-51-0221 Rev. 5 & 7-51-0233 Rev. 0

50 Dia. GI Pipe and 100 Dia. GI Pipe mentioned wherever in the standards shall be read as 50 NB (Medium Grade) GI Pipe and 100 NB (Medium Grade) GI Pipe respectively.

6.23 CONTRACTOR shall provide separate RCBO & MCB or separate ELCB & MCB for each lighting outgoing circuit at local lighting distribution panel. Common RCBO/ELCB + MCB unit is not acceptable. ELCB/RCBO shall be rated for 30mA in field and 300mA in indoors.

- 6.24 For wiring just above the false ceiling, METSEC channel shall be used. For wiring on true ceiling black enameled surface conduits shall be used.
- 6.25 All Copper Control cables shall be twisted paired (individual shielded and overall shielded) only. Minimum 10% spare pair or minimum 1 spare pair shall be provided.
- 6.26 All Multi-Function Meter (MFM) in HV & MV switchboards shall be communicable type. Complete data of MFM shall be accessible in the SAS (through switchboard level Ethernet switches) & associated SAS Laptop/ HMI. The protocol for communication shall be over RS-485 or fibre optic cable, preferably with IEC protocol. Accordingly, protocol convertors/gateways at suitable locations as required shall be provided by CONTRACTOR for data integration on IEC 61850 protocol from Master Ethernet switch to Owner's ECS system.

## **7 SPARES**

- 7.1 Commissioning spares for all electrical equipments are included in Package Contractor's scope of supply and shall be included in the base price.
- 7.2 Mandatory Electrical spares as per document No. B269-999-16-50-SL-0020, are included in vendor's scope of supply.
- 7.3 Unit rates for two years recommended O&M spares along with list of recommended spares for each equipment provided as a part of this package, shall be provided by CONTRACTOR along with offer
- 7.4 Recommended list of maintenance spares for two years operation shall include the following as a minimum for motors. Vendor shall ensure to quote for the same.
- Bearing for DE/NDE-one set
  - Terminal box cover with screws
  - Fan
  - Terminal block

## **8 INSTALLATION, FIELD TESTING & COMMISSIONING AT SITE**

- 8.1 Contractor shall carry out the installation, field testing and commissioning of all items including installation in field, testing and commissioning of free issue items in accordance with Consultant installation standard & standard specification attached with tender.
- 8.2 Contractor 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.
- 8.3 Contractor shall comply with the requirements of Mechanical Completion as described in relevant section of Bid document.
- 8.4 Obtaining clearance for energizing the complete electrical facilities covered under this tender and approval of installation / drawings from central electrical inspector and any other concerned approving authority e.g. CCOE (PESO), OISD etc. shall be in the scope of the contractor.
- 8.5 Contractor shall also avail OEM (Original Equipment Manufacturer) services for testing and commissioning of equipment as listed elsewhere in the tender. However for other equipment, contractor shall ensure services of manufacturers' representatives for supervision of installation, testing and commissioning.
- 8.6 Testing and commissioning of all free issue relays for installation in Owner's sending/receiving end switchboard feeders, relay setting for all these feeders at site including supply, installation and testing of application software as required for numerical relays and Owner's laptop/ HMI (of 220 kV, 66kV and 33kV / 6.6 kV / 415V) are included in the scope of vendor. Relay manufacturer shall be solely responsible for numerical relays integration, relay setting etc. for the complete switchboards.

- 8.7 Splicing of FO cable and taking over from cable laying contractor and glanding of same shall be in the scope of CONTRACTOR. OTDR test shall be done mandatorily after taking over from cable laying contractor.
- 8.8 Structural steel support shall be fabricated of rolled MS sections after shot blasting, welding, bolting, riveting, supply of necessary anchor bolts and grouting etc. including supply of paint and applying one coat of anti-rust primer and two finished coats of approved synthetic enamel paint (suitable for highly corrosive environment) as per painting specification attached with tender.
- 8.9 Cable support structure below the GIS shall NOT be fixed to the floor/ wall, instead shall be connected to GIS structure, to avoid this structure coming off the fixing during the short circuit.
- 8.10 Chequered plate shall be painted in accordance with painting specification 6-79-0020 enclosed elsewhere in the bid package.
- 8.11 HV cables being free issued by owner shall be made available at OWNER's warehouse. Transportation of cables from warehouse to site, laying and termination of cables including supply of all cable laying accessories, cable joints, cable termination kits, etc. is in scope of contractor.
- 8.12 Painting/ marking/ numbering of all buses of switchboards and each incoming/ outgoing feeder with details of tag number, feeder rating in front and rear of panel and all other equipments viz. transformers, lighting fixtures, FA devices, junction boxes, motors, welding receptacles, convenience receptacles, local control stations, etc. shall be done as per requirement of Engineer-in-charge at site.

## **9 INSPECTION AND TESTING AT MANUFACTURER'S WORKS**

- 9.1 All major electrical equipment and material shall be subject to inspection by owner/ Consultant or authorized representative at manufacturers' works. Contractor/Vendor/ Sub-Vendor shall furnish all necessary information concerning the supply to owner/ Consultant.
- 9.2 During fabrication, all the equipment shall be subject to inspection by owner/Consultant or by an agency authorized by the owner to assess the progress of work as well as to ascertain that only quality raw material is used.
- 9.3 Type, routine and acceptance tests to be conducted on all equipment shall include all tests as specified in standard specifications & data sheets enclosed with the package.
- 9.4 Contractor shall ensure that the electrical equipment procured have type test certificates.
- 9.5 All routine and acceptance tests as specified by the applicable standards shall be carried out by the contractor/vendor/sub-vendor and these tests shall be witnessed by owner/ Consultant or an agency authorized by owner/ Consultant Any other test and quality assurance requirements as defined elsewhere in the package shall also be complied.
- 9.6 All the equipment offered shall have valid type test certificates of recognized testing house such as CPRI, CMRI, PTB, BASEEFA, UL or equivalent.
- 9.7 Wherever, EIL Inspection and test plan is not available for electrical equipments e.g. Solar rooftop photovoltaic system, etc., CONTRACTOR/ Supplier shall develop QAPs using the specific requirements of Inspection and testing as covered in the tender. The QAPs are required to be reviewed and approved by EIL/Owner.

## **10 STATUTORY APPROVAL OF WORKS**

- 10.1 The contractor shall obtain approvals from the concerned electrical inspectorate for installation drawings and engineering of the electrical system and equipment covered under the contractor's scope. Any modification or additional requirements of the electrical inspectorate shall have to be carried out by the contractor at his own cost without affecting time schedule. Arranging for any other approvals required for the complex, from agencies such as CCOE, CEA etc. are



included in the contractor's scope. For electrical equipment to be installed in hazardous area, statutory approval certificates shall be furnished by the contractor. Any additional testing, if required, shall be carried out by the contractor without affecting project time schedule at no extra cost to Owner.

- 10.2 The inspection and acceptance of the work as above shall not absolve the Contractor from any of his responsibilities under this package. Obtaining clearance for energizing the complete electrical facilities covered under this tender, and approval of installation and drawings from the Chief Electrical Inspectorate/CEA/HVPNL/Power Supply Company shall be the responsibility of the contractor.

## **11 MAKES OF EQUIPMENT AND COMPONENTS**

- 11.1 List of approved vendors for Electrical equipment/components is as mentioned elsewhere in the Master Vendor List, attached with the tender.
- 11.2 All electrical equipment shall be brand new with state of art technology and proven track record. No prototype shall be offered. The make and type of equipment, if not specified in this bid document, shall be subject to approval of owner/ Consultant.
- 11.3 Additional makes of imported items shall be subject to Owner/Consultant's approval during detailed engineering.
- 11.4 Vendor may procure material from any of the listed vendors. However current validity and range of approval as per Consultant enlistment letter, workload, stability and solvency need to be verified by the vendor before placement of order.
- 11.5 Vendor shall ensure the availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply. Vendor/ sub-vendor shall give a notice of at least one year to the end user of equipment and PMC before phasing out the products/spares to enable the end user for placement of order for spares and services.

| <div>इंजीनियर्स<br/>इंडिया लिमिटेड</div> <div>ENGINEERS<br/>INDIA LIMITED</div> <div>(भारत सरकार का उपक्रम)<br/>(A Govt. of India Undertaking)</div> |                              |                                  |                                                                                             | 220 kV GIS FEEDER DETAIL DATASHEET<br>(HV-100103) |             |                    |          |                                          |                        |                                  |                   |                   |               | Data sheet No.         |                                              |                       |        |         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------|-------------|--------------------|----------|------------------------------------------|------------------------|----------------------------------|-------------------|-------------------|---------------|------------------------|----------------------------------------------|-----------------------|--------|---------|
|                                                                                                                                                                                                                                      |                              |                                  |                                                                                             |                                                   |             |                    |          |                                          |                        |                                  |                   |                   |               | B269-999-16-50-DS-0034 |                                              |                       |        |         |
|                                                                                                                                                                                                                                      |                              |                                  |                                                                                             |                                                   |             |                    |          |                                          |                        |                                  |                   |                   |               | Rev.No. E              |                                              |                       |        |         |
| E                                                                                                                                                                                                                                    | 18-05-2022                   | REVISED & REISSUED WITH TA-02    |                                                                                             |                                                   |             |                    |          | MKM                                      |                        |                                  | RAHUL             |                   |               | HK                     |                                              |                       |        |         |
| D                                                                                                                                                                                                                                    | 06-04-2022                   | REVISED & ISSUED WITH TA-01      |                                                                                             |                                                   |             |                    |          | MKM                                      |                        |                                  | RAHUL             |                   |               | HK                     |                                              |                       |        |         |
| C                                                                                                                                                                                                                                    | 27-09-2021                   | REVISED AND REISSUED WITH TENDER |                                                                                             |                                                   |             |                    |          | AKG                                      |                        |                                  | HK                |                   |               | HK                     |                                              |                       |        |         |
| B                                                                                                                                                                                                                                    | 05-07-2021                   | REVISED AND REISSUED WITH TENDER |                                                                                             |                                                   |             |                    |          | AKG                                      |                        |                                  | HK                |                   |               | HK                     |                                              |                       |        |         |
| Rev.                                                                                                                                                                                                                                 | Date                         |                                  |                                                                                             |                                                   |             |                    |          | Prepared                                 |                        |                                  | Checked           |                   |               | Approved               |                                              |                       |        |         |
|                                                                                                                                                                                                                                      |                              |                                  |                                                                                             |                                                   |             |                    |          |                                          |                        |                                  |                   |                   |               |                        |                                              |                       |        |         |
| Project                                                                                                                                                                                                                              |                              | P25 PANIPAT                      |                                                                                             |                                                   |             | Unit               |          | SUBSTATION                               |                        |                                  |                   | Client            |               |                        | IOCL-PR                                      |                       |        |         |
| Switchgear No.                                                                                                                                                                                                                       |                              | HV-100103                        |                                                                                             |                                                   |             | Location           |          | Substation-100 (MRSS)                    |                        |                                  |                   | Auto/ Manual Xfr. |               |                        | Not Applicable                               |                       |        |         |
| Voltage                                                                                                                                                                                                                              |                              | 220 kV                           |                                                                                             |                                                   |             | Curent             |          | 2000 Amps                                |                        |                                  |                   | Fault Level       |               |                        | 50 kA (3 Sec)                                |                       |        |         |
| Bus Differential                                                                                                                                                                                                                     |                              | Required                         |                                                                                             |                                                   |             | Bus Diff. CT Ratio |          | 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        | 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-1 from PR 220kV Indoor GIS in S/S-64: Existing Spare feeder of Bus-1 (With Line PT) |                                                   | 1           |                    | 2000     | 2000                                     | 2000                   | 2000                             | -                 | 3                 | 1             | 630                    | 0036                                         |                       | Note-4 |         |
| 2                                                                                                                                                                                                                                    |                              |                                  | Incomer-2 from PR 220kV Indoor GIS in S/S-64: Existing Spare feeder of Bus-2 (With Line PT) |                                                   | 1           |                    | 2000     | 2000                                     | 2000                   | 2000                             | -                 | 3                 | 1             | 630                    | 0036                                         |                       | Note-4 |         |
| 3                                                                                                                                                                                                                                    |                              |                                  | Incomer-3 from PR 220kV Indoor GIS in S/S-64: New extended feeder of Bus-1 (With Line PT)   |                                                   |             | 1                  | 2000     | 2000                                     | 2000                   | 2000                             | -                 | 3                 | 1             | 630                    | 0036                                         |                       | Note-4 |         |
| 4                                                                                                                                                                                                                                    |                              |                                  | Incomer-4 from PR 220kV Indoor GIS in S/S-64: New extended feeder of Bus-2 (With Line PT)   |                                                   |             | 1                  | 2000     | 2000                                     | 2000                   | 2000                             | -                 | 3                 | 1             | 630                    | 0036                                         |                       | Note-4 |         |
| 5                                                                                                                                                                                                                                    |                              |                                  | Bus Coupler 1A-1B                                                                           |                                                   | 1           |                    | 2000     | 2000                                     | 2000                   | -                                | -                 | -                 | -             | -                      | 0038                                         |                       |        |         |
| 6                                                                                                                                                                                                                                    |                              |                                  | Bus Coupler 2A-2B                                                                           |                                                   |             | 1                  | 2000     | 2000                                     | 2000                   | -                                | -                 | -                 | -             | -                      | 0038                                         |                       |        |         |
| 7                                                                                                                                                                                                                                    |                              |                                  | Bus Sectionalizer 1A-2A                                                                     |                                                   | 1           |                    | 2000     | 2000                                     | 2000                   | -                                | -                 | -                 | -             | -                      | 0038                                         |                       |        |         |
| 8                                                                                                                                                                                                                                    |                              |                                  | Bus Sectionalizer 1B-2B                                                                     |                                                   |             | 1                  | 2000     | 2000                                     | 2000                   | -                                | -                 | -                 | -             | -                      | 0038                                         |                       |        |         |

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|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------|--------------------------------|---------------|---------------------------------------------------|--------------------|----------|---------------------------------------|------------------------|-------------------------------|----------------|-------------------|---------------|----------|--------------------------------------------|---------------------|--------|---------|
|                                                                                                                                          |                              |                                  |                                |               |                                                   |                    |          |                                       |                        |                               |                |                   |               |          | B269-999-16-50-DS-0034                     |                     |        |         |
|                                                                                                                                          |                              |                                  |                                |               |                                                   |                    |          |                                       |                        |                               |                |                   |               |          | Rev.No. E                                  |                     |        |         |
| E                                                                                                                                        | 18-05-2022                   | REVISED & REISSUED WITH TA-02    |                                |               |                                                   |                    |          | MKM                                   |                        |                               | RAHUL          |                   |               | HK       |                                            |                     |        |         |
| D                                                                                                                                        | 06-04-2022                   | REVISED & ISSUED WITH TA-01      |                                |               |                                                   |                    |          | MKM                                   |                        |                               | RAHUL          |                   |               | HK       |                                            |                     |        |         |
| C                                                                                                                                        | 27-09-2021                   | REVISED AND REISSUED WITH TENDER |                                |               |                                                   |                    |          | AKG                                   |                        |                               | HK             |                   |               | HK       |                                            |                     |        |         |
| B                                                                                                                                        | 05-07-2021                   | REVISED AND REISSUED WITH TENDER |                                |               |                                                   |                    |          | AKG                                   |                        |                               | HK             |                   |               | HK       |                                            |                     |        |         |
| Rev.                                                                                                                                     | Date                         |                                  |                                |               |                                                   |                    |          | Prepared                              |                        |                               | Checked        |                   |               | Approved |                                            |                     |        |         |
|                                                                                                                                          |                              |                                  |                                |               |                                                   |                    |          |                                       |                        |                               |                |                   |               |          |                                            |                     |        |         |
| Project                                                                                                                                  |                              | P25 PANIPAT                      |                                |               |                                                   | Unit               |          | SUBSTATION                            |                        |                               |                | Client            |               |          | IOCL-PR                                    |                     |        |         |
| Switchgear No.                                                                                                                           |                              | HV-100103                        |                                |               |                                                   | Location           |          | Substation-100 (MRSS)                 |                        |                               |                | Auto/ Manual Xfr. |               |          | Not Applicable                             |                     |        |         |
| Voltage                                                                                                                                  |                              | 220 kV                           |                                |               |                                                   | Curent             |          | 2000 Amps                             |                        |                               |                | Fault Level       |               |          | 50 kA (3 Sec)                              |                     |        |         |
| Bus Differential                                                                                                                         |                              | Required                         |                                |               |                                                   | Bus Diff. CT Ratio |          | 2000/1                                |                        |                               |                |                   |               |          |                                            |                     |        |         |
|                                                                                                                                          |                              |                                  |                                |               |                                                   |                    |          |                                       |                        |                               |                |                   |               |          |                                            |                     |        |         |
| S.No.                                                                                                                                    | Feeder Nameplate Inscription |                                  |                                |               | Bus Section                                       |                    |          | Breaker Rating/<br>Feeder Designation | CT Primary Rating (A)* |                               |                |                   | Cable Details |          |                                            | Reference Datasheet |        | Remarks |
|                                                                                                                                          | Panel No. @                  | Feeder No. #                     | Feeder Description             | Rating (MVA)# | Left                                              | Right              | Metering |                                       | Protection             |                               |                | Run               | Core          | Size     | EIL Hardware Datasheet B269-999-16-50-0034 | Vendor Scheme No.@  |        |         |
|                                                                                                                                          |                              |                                  |                                |               |                                                   |                    |          |                                       | O/C,S/C, E/F           | Trafo/<br>Feeder Differential | REF Protection |                   |               |          |                                            |                     |        |         |
| 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                                                                                                                                       |                              |                                  | Spare Transformer Feeder-1     | 200           | 1                                                 |                    | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 14                                                                                                                                       |                              |                                  | Spare Transformer Feeder-2     | 200           | 1                                                 |                    | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 15                                                                                                                                       |                              |                                  | Transformer Feeder (TR-100011) | 200           | 1                                                 |                    | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 16                                                                                                                                       |                              |                                  | Transformer Feeder (TR-100013) | 200           | 1                                                 |                    | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 17                                                                                                                                       |                              |                                  | Transformer Feeder (TR-100012) | 200           |                                                   | 1                  | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 18                                                                                                                                       |                              |                                  | Transformer Feeder (TR-100014) | 200           |                                                   | 1                  | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 19                                                                                                                                       |                              |                                  | Transformer Feeder (Spare)-3   | 200           |                                                   | 1                  | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |
| 20                                                                                                                                       |                              |                                  | Transformer Feeder (Spare)-4   | 200           |                                                   | 1                  | 1250A    | 630                                   | 630                    | 630                           | 630            | 3                 | 1             | 630      | 0040                                       |                     | Note-4 |         |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                              |                                  |                       |                                                                 |                   |                |                                          |                        |               |                                                        |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------|-----------------------|-----------------------------------------------------------------|-------------------|----------------|------------------------------------------|------------------------|---------------|--------------------------------------------------------|-----|---------------|-------------|------|---------------------|----------------------------------------------|---------|-----------------------|--|----------------|-----------|----------|-----------------------|--|-------------------|----------------|--|---------|--------|--------|-----------|--|-------------|---------------|--|------------------|----------|--------------------|--------|--|--|--|--|
|  <b>ENGINEERS INDIA LIMITED</b><br><small>(भारत सरकार का उपक्रम) (A Govt. of India Undertaking)</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                                  |                       | <b>220 kV GIS FEEDER DETAIL DATASHEET</b><br><b>(HV-100103)</b> |                   |                |                                          |                        |               | <b>Data sheet No.</b><br><b>B269-999-16-50-DS-0034</b> |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| <b>Rev.No. E</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |                                  |                       |                                                                 |                   |                |                                          |                        |               |                                                        |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 18-05-2022                   | REVISED & REISSUED WITH TA-02    |                       |                                                                 |                   | MKM            |                                          | RAHUL                  |               | HK                                                     |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 06-04-2022                   | REVISED & ISSUED WITH TA-01      |                       |                                                                 |                   | MKM            |                                          | RAHUL                  |               | HK                                                     |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 27-09-2021                   | REVISED AND REISSUED WITH TENDER |                       |                                                                 |                   | AKG            |                                          | HK                     |               | HK                                                     |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 05-07-2021                   | REVISED AND REISSUED WITH TENDER |                       |                                                                 |                   | AKG            |                                          | HK                     |               | HK                                                     |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| Rev.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Date                         |                                  |                       |                                                                 |                   | Prepared       |                                          | Checked                |               | Approved                                               |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| <table border="1"> <tr> <td>Project</td> <td>P25 PANIPAT</td> <td>Unit</td> <td colspan="2">SUBSTATION</td> <td>Client</td> <td colspan="2">IOCL-PR</td> </tr> <tr> <td>Switchgear No.</td> <td>HV-100103</td> <td>Location</td> <td colspan="2">Substation-100 (MRSS)</td> <td>Auto/ Manual Xfr.</td> <td colspan="2">Not Applicable</td> </tr> <tr> <td>Voltage</td> <td>220 kV</td> <td>Curent</td> <td colspan="2">2000 Amps</td> <td>Fault Level</td> <td colspan="2">50 kA (3 Sec)</td> </tr> <tr> <td>Bus Differential</td> <td>Required</td> <td>Bus Diff. CT Ratio</td> <td colspan="2">2000/1</td> <td colspan="3"></td> </tr> </table> |                              |                                  |                       |                                                                 |                   |                |                                          |                        |               |                                                        |     | Project       | P25 PANIPAT | Unit | SUBSTATION          |                                              | Client  | IOCL-PR               |  | Switchgear No. | HV-100103 | Location | Substation-100 (MRSS) |  | Auto/ Manual Xfr. | Not Applicable |  | Voltage | 220 kV | Curent | 2000 Amps |  | Fault Level | 50 kA (3 Sec) |  | Bus Differential | Required | Bus Diff. CT Ratio | 2000/1 |  |  |  |  |
| Project                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | P25 PANIPAT                  | Unit                             | SUBSTATION            |                                                                 | Client            | IOCL-PR        |                                          |                        |               |                                                        |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| Switchgear No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | HV-100103                    | Location                         | Substation-100 (MRSS) |                                                                 | Auto/ Manual Xfr. | Not Applicable |                                          |                        |               |                                                        |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 220 kV                       | Curent                           | 2000 Amps             |                                                                 | Fault Level       | 50 kA (3 Sec)  |                                          |                        |               |                                                        |     |               |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |
| Bus Differential                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Required                     | Bus Diff. CT Ratio               | 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              | 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 | Protection    |             |      |                     |                                              |         |                       |  |                |           |          |                       |  |                   |                |  |         |        |        |           |  |             |               |  |                  |          |                    |        |  |  |  |  |

**Notes :**

- \* 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.
- # These shall be finalised during drawing approval stage and shall not have any cost implication.
- @ Data to be furnished by Vendor.
- 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.
- Gas Insulated surge arrestor shall be provided in incomers and all outgoing feeders. Line PT and Bus PT shall also be Gas Insulated Type.
- Bus differential protection and Bus wire check supervision shall be provided for the switchboard including corresponding CTs.
- Independent Bus PT panel shall be provided for all the four buses of the Double Bus GIS switchboard.

| <div>इंजीनियर्स इंडिया लिमिटेड</div> <div>ENGINEERS INDIA LIMITED</div> <div>(भारत सरकार का उद्योग)</div> <div>(A Govt. of India Undertaking)</div> |                              |                                  |                                            | 66 kV GIS FEEDER DETAIL DATASHEET<br>(HV-100111) |             |     |       |                                          |                        |                       |                                  |                   |                   | Data sheet No.         |                |                                             |                       |         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------|--------------------------------------------|--------------------------------------------------|-------------|-----|-------|------------------------------------------|------------------------|-----------------------|----------------------------------|-------------------|-------------------|------------------------|----------------|---------------------------------------------|-----------------------|---------|
|                                                                                                                                                     |                              |                                  |                                            |                                                  |             |     |       |                                          |                        |                       |                                  |                   |                   | B269-999-16-50-DS-0035 |                |                                             |                       |         |
|                                                                                                                                                     |                              |                                  |                                            |                                                  |             |     |       |                                          |                        |                       |                                  |                   |                   | Rev.No. E              |                |                                             |                       |         |
| E                                                                                                                                                   | 18-05-2022                   | REVISED AND REISSUED WITH TA-02  |                                            |                                                  |             |     |       | MKM                                      |                        |                       | RG                               |                   |                   | HK                     |                |                                             |                       |         |
| D                                                                                                                                                   | 06-04-2022                   | REVISED AND REISSUED WITH TA-01  |                                            |                                                  |             |     |       | MKM                                      |                        |                       | RG                               |                   |                   | HK                     |                |                                             |                       |         |
| C                                                                                                                                                   | 27-09-2021                   | REVISED AND REISSUED WITH TENDER |                                            |                                                  |             |     |       | AKG                                      |                        |                       | HK                               |                   |                   | HK                     |                |                                             |                       |         |
| Rev.                                                                                                                                                | Date                         |                                  |                                            |                                                  |             |     |       | Prepared                                 |                        |                       | Checked                          |                   |                   | Approved               |                |                                             |                       |         |
|                                                                                                                                                     |                              |                                  |                                            |                                                  |             |     |       |                                          |                        |                       |                                  |                   |                   |                        |                |                                             |                       |         |
| Project                                                                                                                                             |                              | P25 PANIPAT                      |                                            |                                                  |             |     |       | Unit                                     |                        | SUBSTATION            |                                  |                   | Client            |                        | IOCL-PR        |                                             |                       |         |
| Switchgear No.                                                                                                                                      |                              | HV-100111                        |                                            |                                                  |             |     |       | Location                                 |                        | Substation-100 (MRSS) |                                  |                   | Auto/ Manual Xfr. |                        | Not Applicable |                                             |                       |         |
| Voltage                                                                                                                                             |                              | 66 kV                            |                                            |                                                  |             |     |       | Curent                                   |                        | 3150 Amps             |                                  |                   | Fault Level       |                        | 40 kA (3 Sec)  |                                             |                       |         |
| Bus Differential                                                                                                                                    |                              | Required                         |                                            |                                                  |             |     |       | Bus Diff. CT Ratio                       |                        | 3150/1                |                                  |                   |                   |                        |                |                                             |                       |         |
|                                                                                                                                                     |                              |                                  |                                            |                                                  |             |     |       |                                          |                        |                       |                                  |                   |                   |                        |                |                                             |                       |         |
| 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 Transformer<br>(With Line PT) | 200                                              |             |     | 3     | 2000A                                    | 2000                   | 2000                  | 2000                             | -                 | GIBD              |                        |                | 0042                                        |                       | Note-8  |
| 2                                                                                                                                                   |                              |                                  | Incomer from Transformer<br>(With Line PT) | 200                                              | 3           | 2   |       | 2000A                                    | 2000                   | 2000                  | 2000                             | -                 | GIBD              |                        |                | 0042                                        |                       | Note-8  |
| 3                                                                                                                                                   |                              |                                  | Bus Coupler 1A-2A                          |                                                  | 1           |     |       | 3150A                                    | 3150                   | 3150                  | -                                | -                 | -                 | -                      | -              | 0044                                        |                       |         |
| 4                                                                                                                                                   |                              |                                  | Bus Coupler 3A-3B                          |                                                  |             |     | 1     | 3150A                                    | 3150                   | 3150                  | -                                | -                 | -                 | -                      | -              | 0044                                        |                       |         |
| 5                                                                                                                                                   |                              |                                  | Bus Sectionalizer 1A-2A                    |                                                  |             | 1   |       | 3150A                                    | 3150                   | 3150                  | -                                | -                 | -                 | -                      | -              | 0044                                        |                       |         |
| 6                                                                                                                                                   |                              |                                  | Bus Sectionalizer 2A-2B                    |                                                  |             | 1   |       | 3150A                                    | 3150                   | 3150                  | -                                | -                 | -                 | -                      | -              | 0044                                        |                       |         |
| 7                                                                                                                                                   |                              |                                  | Bus Sectionalizer 2A-3A                    |                                                  |             |     | 1     | 3150A                                    | 3150                   | 3150                  | -                                | -                 | -                 | -                      | -              | 0044                                        |                       |         |
| 8                                                                                                                                                   |                              |                                  | Bus Sectionalizer 2B-3B                    |                                                  |             |     | 1     | 3150A                                    | 3150                   | 3150                  | -                                | -                 | -                 | -                      | -              | 0044                                        |                       |         |
| 9                                                                                                                                                   |                              |                                  | Bus PT 1A                                  |                                                  | 1           |     |       | -                                        | -                      | -                     | -                                | -                 | -                 | -                      | -              | 0045                                        |                       | Note-7  |
| 10                                                                                                                                                  |                              |                                  | Bus PT 1B                                  |                                                  | 1           |     |       | -                                        | -                      | -                     | -                                | -                 | -                 | -                      | -              | 0045                                        |                       | Note-7  |
| 11                                                                                                                                                  |                              |                                  | Bus PT 2A                                  |                                                  |             | 1   |       | -                                        | -                      | -                     | -                                | -                 | -                 | -                      | -              | 0045                                        |                       | Note-7  |
| 12                                                                                                                                                  |                              |                                  | Bus PT 2B                                  |                                                  |             | 1   |       | -                                        | -                      | -                     | -                                | -                 | -                 | -                      | -              | 0045                                        |                       | Note-7  |
| 13                                                                                                                                                  |                              |                                  | Bus PT 3A                                  |                                                  |             |     | 1     | -                                        | -                      | -                     | -                                | -                 | -                 | -                      | -              | 0045                                        |                       | Note-7  |
| 14                                                                                                                                                  |                              |                                  | Bus PT 3B                                  |                                                  |             |     | 1     | -                                        | -                      | -                     | -                                | -                 | -                 | -                      | -              | 0045                                        |                       | Note-7  |
| 15                                                                                                                                                  |                              |                                  | Transformer Feeder                         | 12.5                                             |             | 2   | 2     | 1000A                                    | 120                    | 120                   | 120                              | -                 | 3                 | 1                      | 300            | 0046                                        |                       | Note-4  |
| 16                                                                                                                                                  |                              |                                  | Transformer Feeder                         | 16                                               |             | 1   | 1     | 1000A                                    | 160                    | 160                   | 160                              | -                 | 3                 | 1                      | 300            | 0046                                        |                       | Note-4  |

for reference

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |                                  |                              |                                                                |             |                    |       |                                          |          |                                                                            |                                  |                   |     |      |                     |                                             |         |                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------|------------------------------|----------------------------------------------------------------|-------------|--------------------|-------|------------------------------------------|----------|----------------------------------------------------------------------------|----------------------------------|-------------------|-----|------|---------------------|---------------------------------------------|---------|-----------------------|
|  <b>ENGINEERS INDIA LIMITED</b><br><small>(A Govt. of India Undertaking)</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |                                  |                              | <b>66 kV GIS FEEDER DETAIL DATASHEET</b><br><b>(HV-100111)</b> |             |                    |       |                                          |          | <b>Data sheet No.</b><br><b>B269-999-16-50-DS-0035</b><br><b>Rev.No. E</b> |                                  |                   |     |      |                     |                                             |         |                       |
| E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 18-05-2022                   | REVISED AND REISSUED WITH TA-02  |                              |                                                                |             | MKM                |       | RG                                       |          | HK                                                                         |                                  |                   |     |      |                     |                                             |         |                       |
| D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 06-04-2022                   | REVISED AND REISSUED WITH TA-01  |                              |                                                                |             | MKM                |       | RG                                       |          | HK                                                                         |                                  |                   |     |      |                     |                                             |         |                       |
| C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 27-09-2021                   | REVISED AND REISSUED WITH TENDER |                              |                                                                |             | AKG                |       | HK                                       |          | HK                                                                         |                                  |                   |     |      |                     |                                             |         |                       |
| Rev.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Date                         |                                  |                              |                                                                |             | Prepared           |       | Checked                                  |          | Approved                                                                   |                                  |                   |     |      |                     |                                             |         |                       |
| Project                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              | P25 PANIPAT                      |                              |                                                                |             | Unit               |       | SUBSTATION                               |          | Client                                                                     |                                  | IOCL-PR           |     |      |                     |                                             |         |                       |
| Switchgear No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                              | HV-100111                        |                              |                                                                |             | Location           |       | Substation-100 (MRSS)                    |          | Auto/ Manual Xfr.                                                          |                                  | Not Applicable    |     |      |                     |                                             |         |                       |
| Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              | 66 kV                            |                              |                                                                |             | Curent             |       | 3150 Amps                                |          | Fault Level                                                                |                                  | 40 kA (3 Sec)     |     |      |                     |                                             |         |                       |
| Bus Differential                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              | Required                         |                              |                                                                |             | Bus Diff. CT Ratio |       | 3150/1                                   |          |                                                                            |                                  |                   |     |      |                     |                                             |         |                       |
| S.No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Feeder Nameplate Inscription |                                  |                              |                                                                | Bus Section |                    |       | CT Primary Rating (A)*                   |          |                                                                            |                                  | Cable Details     |     |      | Reference Datasheet |                                             | Remarks |                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Panel No. @                  | Feeder No. #                     | Feeder Description           | Rating (MVA)#                                                  | Left        | Mid                | Right | Breaker Rating/<br>Feeder<br>Designation | 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 |     |      |                     |                                             |         |                       |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Transformer Feeder           | 20                                                             |             | 1                  | 1     | 1000A                                    | 200      | 200                                                                        | 200                              | -                 | 3   | 1    | 300                 | 0046                                        |         | Note-4                |
| 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Transformer Feeder           | 25                                                             | 1           | 4                  | 6     | 1000A                                    | 250      | 250                                                                        | 250                              | -                 | 3   | 1    | 300                 | 0046                                        |         | Note-4                |
| 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Transformer Feeder           | 31.5                                                           | 2           | 7                  | 6     | 1000A                                    | 320      | 320                                                                        | 320                              | -                 | 3   | 1    | 400                 | 0046                                        |         | Note-4                |
| 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Tie Transformer Feeder - I/C | 125                                                            | 1           | 1                  |       | 1250A                                    | 1250     | 1250                                                                       | 1250                             | 1250              | 6   | 1    | 1000                | 0048                                        |         | Note-4                |
| 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Tie Transformer Feeder - O/G | 125                                                            | 1           | 1                  |       | 1250A                                    | 1250     | 1250                                                                       | 1250                             | 1250              | 6   | 1    | 1000                | 0047                                        |         | Note-4                |
| 24                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Transformer feeder-Spare     | 20                                                             |             | 1                  | 1     | 1000A                                    | 200      | 200                                                                        | 200                              | -                 | 3   | 1    | 300                 | 0046                                        |         | Note-4                |
| 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Transformer feeder-Spare     | 25                                                             |             | 1                  | 1     | 1000A                                    | 250      | 250                                                                        | 250                              | -                 | 3   | 1    | 300                 | 0046                                        |         | Note-4                |
| 26                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                                  | Transformer feeder-Spare     | 31.5                                                           | 1           | 1                  | 2     | 1000A                                    | 320      | 320                                                                        | 320                              | -                 | 3   | 1    | 400                 | 0046                                        |         | Note-4                |
| <b>Notes :</b><br>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.<br>2 `#` These shall be finalised during drawing approval stage and shall not have any cost implication.<br>3 `@` Data to be furnished by Vendor.<br>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.<br>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.  <br>6 Bus differential protection and Bus wire check supervision shall be provided for the switchboard including corresponding CTs.<br>7 Independent Bus PT panel shall be provided for all the four buses of the Double Bus GIS switchboard.<br>8 For two numbers future incomers GIBD/Cable connection shall be finalised post order during detail engineering with any time and cost implication to EIL/Owner. |                              |                                  |                              |                                                                |             |                    |       |                                          |          |                                                                            |                                  |                   |     |      |                     |                                             |         |                       |



## TYPICAL ECS IO LIST

### 220 KV GIS PACKAGE

**TENDER NO. B269-999-16-50-EB-T-0020**

**PROJECT : PANIPAT REFINERY EXPANSION (P-25) PROJECT**

**CLIENT : M/s INDIAN OIL CORPORATION LTD**

**CONSULTANT : ENGINEERS INDIA LTD**

**EIL JOB NO. : B269**

|                                                                                    |            |                                            |                                           |                        |          |
|------------------------------------------------------------------------------------|------------|--------------------------------------------|-------------------------------------------|------------------------|----------|
| C                                                                                  | 13.05.2022 | Revised & Reissued with Tender             | MKM                                       | RG                     | HK       |
| B                                                                                  | 05.07.2021 | Revised and Reissued with tender           | AKG                                       | HK                     | HK       |
| A                                                                                  | 11.05.2020 | Issued with tender                         | AKG                                       | HK                     | HK       |
| Rev.                                                                               | Date       | Subject                                    | By                                        | Checked                | Approved |
|  |            | Project : P25 PROJECT<br>Client : M/s IOCL | TYPICAL ECS IO LIST<br>220 KV GIS PACKAGE | Drawing Number.        | Rev      |
|                                                                                    |            |                                            |                                           | B269-999-16-50-DS-0054 | C        |

TECHNICAL AMENDMENT.02

| EQUIPMENT DESCRIPTION | FEEDER TYPE | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                     | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                                        |
|-----------------------|-------------|------------------|-----------------------|---------------------------------------------|---------------|-----------------|-----------|----------------------------------------------------------------|
| 220 & 66 kV DBB GIS   | INCOMER     | AI               | MEASURING             | R-Phase Current                             |               |                 | HARDWIRED | FROM MEASURING CT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL |
| 220 & 66 kV DBB GIS   | INCOMER     | AI               | MEASURING             | Y-Phase Current                             |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | AI               | MEASURING             | B-Phase Current                             |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | AI               | MEASURING             | Three Phase Real Power (Bi-directional)     |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | AI               | MEASURING             | Three Phase Reactive Power (Bi-directional) |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | AI               | MEASURING             | Power Factor                                |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | CB in Service and                           | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | CB in Service and                           | Open          | Closed          | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Bus Side Isolator 1                         | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Bus Side Isolator 1                         | Open          | Closed          | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Bus Side Isolator 1 Earth Switch            | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Bus Side Isolator 1 Earth Switch            | Open          | Closed          | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Bus Side Isolator 2                         | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Bus Side Isolator 2                         | Open          | Closed          | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Line Side Isolator 1                        | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Line Side Isolator 1                        | Open          | Closed          | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Line Side Isolator 1 Earth Switch           | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Line Side Isolator 1 Earth Switch           | Open          | Closed          | HARDWIRED |                                                                |

| EQUIPMENT DESCRIPTION | FEEDER TYPE | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                        | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                       |
|-----------------------|-------------|------------------|-----------------------|------------------------------------------------|---------------|-----------------|-----------|-------------------------------|
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | High Speed Earth Switch                        | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | High Speed Earth Switch                        | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Feeder Differential                            | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Relay 86 - Lock Out Relay                      | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Gas Pressure Low                               | Operated=1    |                 | HARDWIRED | Separate for each compartment |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | No Voltage Signal from Cap. Voltage Detector   | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Local Remote Selector Switch                   | Local         |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DI               | STATUS                | Local Remote Selector Switch                   | Remote        |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | CB Close Command                               | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Trip form ECS (TC-1)                           | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Trip from ECS (TC-2)                           | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Close Inhibit (From ECS)                       | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Bus Side Isolator 1 Open Command               | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Bus Side Isolator 1 Close Command              | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Open Command  | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Close Command | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Bus Side Isolator 2 Open Command               | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | INCOMER     | DO               | COMMAND               | Bus Side Isolator 2 Close Command              | Activated=1   |                 | HARDWIRED |                               |

| EQUIPMENT DESCRIPTION | FEEDER TYPE             | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                     | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                                        |
|-----------------------|-------------------------|------------------|-----------------------|---------------------------------------------|---------------|-----------------|-----------|----------------------------------------------------------------|
| 220 & 66 kV DBB GIS   | INCOMER                 | DO               | COMMAND               | Line Side Isolator Open Command             | Activated=1   |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DO               | COMMAND               | Line Side Isolator Close Command            | Activated=1   |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DI               | STATUS                | Pole Discordance                            | Operated=1    |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DI               | STATUS                | Relay 95 - Trip Circuit - 1 Supervision     | Operated=1    |                 | RELAY LAN |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DI               | STATUS                | Relay 95 - Trip Circuit - 2 Supervision     | Operated=1    |                 | RELAY LAN |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DI               | STATUS                | Relay 80                                    | Operated=1    |                 | RELAY LAN |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DI               | STATUS                | Tripped on Undervoltage                     | Activated=1   |                 | RELAY LAN |                                                                |
| 220 & 66 kV DBB GIS   | INCOMER                 | DI               | STATUS                | Numerical Relay                             | Unhealthy=1   |                 | RELAY LAN | For each type of Relay                                         |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | AI               | MEASURING             | R-Phase Current                             |               |                 | HARDWIRED | FROM MEASURING CT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | AI               | MEASURING             | Y-Phase Current                             |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | AI               | MEASURING             | B-Phase Current                             |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | AI               | MEASURING             | Three Phase Real Power (Bi-directional)     |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | AI               | MEASURING             | Three Phase Reactive Power (Bi-directional) |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | AI               | MEASURING             | Power Factor                                |               |                 | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | CB in Service and                           | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | CB in Service and                           | Open          | Closed          | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Cable Side Isolator 1                       | Closed        | Open            | HARDWIRED |                                                                |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Cable Side Isolator 1                       | Open          | Closed          | HARDWIRED |                                                                |

| EQUIPMENT DESCRIPTION | FEEDER TYPE             | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                      | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                       |
|-----------------------|-------------------------|------------------|-----------------------|----------------------------------------------|---------------|-----------------|-----------|-------------------------------|
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Cable Side Isolator 1 Earth Switch           | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Cable Side Isolator 1 Earth Switch           | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Outgoing Cable Earth Switch                  | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Outgoing Cable Earth Switch                  | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Line Side Isolator 1                         | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Line Side Isolator 1                         | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Line Side Isolator 1 Earth Switch            | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Line Side Isolator 1 Earth Switch            | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | High Speed Earth Switch                      | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | High Speed Earth Switch                      | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Feeder Differential for Cable                | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Feeder Differential for Line                 | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Relay 86 - Lock Out Relay                    | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Gas Pressure Low                             | Operated=1    |                 | HARDWIRED | Separate for each compartment |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | No Voltage Signal from Cap. Voltage Detector | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Local Remote Selector Switch                 | Local         |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Local Remote Selector Switch                 | Remote        |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | CB Close Command                             | Activated=1   |                 | HARDWIRED |                               |

| EQUIPMENT DESCRIPTION | FEEDER TYPE             | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                        | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                |
|-----------------------|-------------------------|------------------|-----------------------|------------------------------------------------|---------------|-----------------|-----------|------------------------|
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Trip form ECS (TC-1)                           | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Trip from ECS (TC-2)                           | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Close Inhibit (From ECS)                       | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Bus Side Isolator 1 Open Command               | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Bus Side Isolator 1 Close Command              | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Open Command  | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Close Command | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Bus Side Isolator 2 Open Command               | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Bus Side Isolator 2 Close Command              | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Line Side Isolator Open Command                | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DO               | COMMAND               | Line Side Isolator Close Command               | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Pole Discordance                               | Operated=1    |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Relay 95 - Trip Circuit - 1 Supervision        | Operated=1    |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Relay 95 - Trip Circuit - 2 Supervision        | Operated=1    |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Relay 80                                       | Operated=1    |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Tripped on Undervoltage                        | Activated=1   |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | ISOLATING BREAKER PANEL | DI               | STATUS                | Numerical Relay                                | Unhealthy=1   |                 | RELAY LAN | For each type of Relay |
| 220 & 66 kV DBB GIS   | LINE PT                 | AI               | MEASURING             | R-Y Line Voltage                               |               |                 | HARDWIRED |                        |



| EQUIPMENT DESCRIPTION | FEEDER TYPE | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                     | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                                             |
|-----------------------|-------------|------------------|-----------------------|---------------------------------------------|---------------|-----------------|-----------|---------------------------------------------------------------------|
| 220 & 66 kV DBB GIS   | LINE PT     | AI               | MEASURING             | Y-B Line Voltage                            |               |                 | HARDWIRED | FROM PT TO TRANSDUCERS IN ECS TRANSDUCER PANEL                      |
| 220 & 66 kV DBB GIS   | LINE PT     | AI               | MEASURING             | R-B Line Voltage                            |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | LINE PT     | AI               | MEASURING             | Line Frequency                              |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | LINE PT     | DI               | STATUS                | Line PT Primary Side Disconnecter           | OPEN          |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | LINE PT     | DI               | STATUS                | Line PT Primary Side Disconnecter           | CLOSED        |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | LINE PT     | DI               | STATUS                | Line PT Primary Side Disconnecter           | EARTHED       |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | LINE PT     | DI               | STATUS                | Line PT Secondary MCB                       | Tripped=1     |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | LINE PT     | DI               | STATUS                | Line                                        | Dead = 1      |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | AI               | MEASURING             | R-Phase Current                             |               |                 | HARDWIRED | FROM MEASURING CT / PT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL |
| 220 & 66 kV DBB GIS   | PLANT FDR   | AI               | MEASURING             | Y-Phase Current                             |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | AI               | MEASURING             | B-Phase Current                             |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | AI               | MEASURING             | Three Phase Real Power (Bi-directional)     |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | AI               | MEASURING             | Three Phase Reactive Power (Bi-directional) |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | AI               | MEASURING             | Power Factor                                |               |                 | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | CB in Service and                           | Closed        | Open            | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | CB in Service and                           | Open          | Closed          | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Bus Side Isolator 1                         | Closed        | Open            | HARDWIRED |                                                                     |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Bus Side Isolator 1                         | Open          | Closed          | HARDWIRED |                                                                     |

| EQUIPMENT DESCRIPTION | FEEDER TYPE | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                      | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                       |
|-----------------------|-------------|------------------|-----------------------|----------------------------------------------|---------------|-----------------|-----------|-------------------------------|
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Bus Side Isolator 1 Earth Switch             | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Bus Side Isolator 1 Earth Switch             | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Bus Side Isolator 2                          | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Bus Side Isolator 2                          | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Line Side Isolator 1                         | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Line Side Isolator 1                         | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Line Side Isolator 1 Earth Switch            | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Line Side Isolator 1 Earth Switch            | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | High Speed Earth Switch                      | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | High Speed Earth Switch                      | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Feeder Differential                          | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Relay 86 - Lock Out Relay                    | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Gas Pressure Low                             | Operated=1    |                 | HARDWIRED | Separate for each compartment |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | No Voltage Signal from Cap. Voltage Detector | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Local Remote Selector Switch                 | Local         |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DI               | STATUS                | Local Remote Selector Switch                 | Remote        |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DO               | COMMAND               | CB Close Command                             | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | PLANT FDR   | DO               | COMMAND               | Trip form ECS (TC-1)                         | Activated=1   |                 | HARDWIRED |                               |

| EQUIPMENT DESCRIPTION | FEEDER TYPE           | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                        | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                        |
|-----------------------|-----------------------|------------------|-----------------------|------------------------------------------------|---------------|-----------------|-----------|------------------------------------------------|
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Trip from ECS (TC-2)                           | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Close Inhibit (From ECS)                       | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Bus Side Isolator 1 Open Command               | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Bus Side Isolator 1 Close Command              | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Open Command  | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Close Command | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Bus Side Isolator 2 Open Command               | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Bus Side Isolator 2 Close Command              | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Line Side Isolator Open Command                | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DO               | COMMAND               | Line Side Isolator Close Command               | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DI               | STATUS                | Pole Discordance                               | Operated=1    |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DI               | STATUS                | Relay 95 - Trip Circuit - 1 Supervision        | Operated=1    |                 | RELAY LAN |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DI               | STATUS                | Relay 95 - Trip Circuit - 2 Supervision        | Operated=1    |                 | RELAY LAN |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DI               | STATUS                | Relay 80                                       | Operated=1    |                 | RELAY LAN |                                                |
| 220 & 66 kV DBB GIS   | PLANT FDR             | DI               | STATUS                | Numerical Relay                                | Unhealthy=1   |                 | RELAY LAN | For each type of Relay                         |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | AI               | MEASURING             | R-Phase Current (Bi-directional)               |               |                 | HARDWIRED | FROM MEASURING CT / PT CORES TO TRANSDUCERS IN |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | AI               | MEASURING             | Y-Phase Current (Bi-directional)               |               |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | AI               | MEASURING             | B-Phase Current (Bi-directional)               |               |                 | HARDWIRED |                                                |

| EQUIPMENT DESCRIPTION | FEEDER TYPE           | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                     | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                           |
|-----------------------|-----------------------|------------------|-----------------------|---------------------------------------------|---------------|-----------------|-----------|---------------------------------------------------|
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | AI               | MEASURING             | Three Phase Real Power (Bi-directional)     |               |                 | HARDWIRED | CONNECTED TO TRANSDUCCERS IN ECS TRANSDUCER PANEL |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | AI               | MEASURING             | Three Phase Reactive Power (Bi-directional) |               |                 | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | AI               | MEASURING             | Power Factor                                |               |                 | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | CB in Service and                           | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | CB in Service and                           | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Bus Side Isolator 1                         | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Bus Side Isolator 1                         | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Bus Side Isolator 1 Earth Switch            | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Bus Side Isolator 1 Earth Switch            | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Bus Side Isolator 2                         | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Bus Side Isolator 2                         | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Line Side Isolator 1                        | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Line Side Isolator 1                        | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Line Side Isolator 1 Earth Switch           | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Line Side Isolator 1 Earth Switch           | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | High Speed Earth Switch                     | Closed        | Open            | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | High Speed Earth Switch                     | Open          | Closed          | HARDWIRED |                                                   |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Restricted Earth Fault                      | Operated=1    |                 | HARDWIRED |                                                   |

| EQUIPMENT DESCRIPTION | FEEDER TYPE           | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                        | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                       |
|-----------------------|-----------------------|------------------|-----------------------|------------------------------------------------|---------------|-----------------|-----------|-------------------------------|
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Transformer Differential                       | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Relay 86 - Lock Out Relay                      | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Gas Pressure Low                               | Operated=1    |                 | HARDWIRED | Separate for each compartment |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | No Voltage Signal from Cap. Voltage Detector   | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Local Remote Selector Switch                   | Local         |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Local Remote Selector Switch                   | Remote        |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | CB Close Command                               | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Trip form ECS (TC-1)                           | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Trip from ECS (TC-2)                           | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Close Inhibit (From ECS)                       | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Bus Side Isolator 1 Open Command               | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Bus Side Isolator 1 Close Command              | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Open Command  | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Bus Side Isolator 1 Earth Switch Close Command | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Bus Side Isolator 2 Open Command               | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Bus Side Isolator 2 Close Command              | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Line Side Isolator Open Command                | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DO               | COMMAND               | Line Side Isolator Close Command               | Activated=1   |                 | HARDWIRED |                               |

| EQUIPMENT DESCRIPTION | FEEDER TYPE           | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                 | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                   |
|-----------------------|-----------------------|------------------|-----------------------|-----------------------------------------|---------------|-----------------|-----------|---------------------------|
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Pole Discordance                        | Operated=1    |                 | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Relay 95 - Trip Circuit - 1 Supervision | Operated=1    |                 | RELAY LAN |                           |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Relay 95 - Trip Circuit - 2 Supervision | Operated=1    |                 | RELAY LAN |                           |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Relay 80                                | Operated=1    |                 | RELAY LAN |                           |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Numerical Relay                         | Unhealthy=1   |                 | RELAY LAN | For each type of Relay    |
| 220 & 66 kV DBB GIS   | TRANSFORMER / TIE FDR | DI               | STATUS                | Transformer Trouble                     | Operated=1    |                 | RELAY LAN |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | AI               | MEASURING             | Oil Temperature                         |               |                 | HARDWIRED | 4-20mA THROUGH TRAFO MBOX |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | AI               | MEASURING             | Winding Temperature                     |               |                 | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | OLTC L/R Selector Switch                | Local         | Not Local       | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | OLTC L/R Selector Switch                | Remote        | Not Remote      | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | ECS/ RTCC Selector Switch               | ECS           | Not ECS         | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | ECS/ RTCC Selector Switch               | RTCC          | Not RTCC        | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | OLTC I/A Selector Switch                | Independent   | Not Indepen.    | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | OLTC I/A Selector Switch                | Auto          | Not Auto        | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | OLTC Run Mode                           | Master        | Not Master      | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | OLTC Run Mode                           | Follower      | Not Follower    | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | Tap Changer In Progress                 | Activated=1   |                 | HARDWIRED |                           |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER      | DI               | STATUS                | Tap Changer Stuck                       | Activated=1   |                 | HARDWIRED |                           |



| EQUIPMENT DESCRIPTION | FEEDER TYPE      | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS |
|-----------------------|------------------|------------------|-----------------------|-------------------------|---------------|-----------------|-----------|---------|
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DO               | COMMAND               | Tap Raise Command       | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DO               | COMMAND               | Tap Lower Command       | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 1  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 2  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 3  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 4  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 5  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 6  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 7  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 8  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 9  | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 10 | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 11 | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 12 | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 13 | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 14 | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 15 | Activated=1   |                 | HARDWIRED |         |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 16 | Activated=1   |                 | HARDWIRED |         |

| EQUIPMENT DESCRIPTION | FEEDER TYPE      | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION          | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                        |
|-----------------------|------------------|------------------|-----------------------|----------------------------------|---------------|-----------------|-----------|------------------------------------------------|
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | OLTC Tap at Position 17          | Activated=1   |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | TCIV Closed                      | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | Fire Detector Tripped            | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | Oil Drain Valve Open             | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | Extinction in Progress           | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | Cylinder Pressure Low            | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | System Out of Service            | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | NIFPS not in Auto                | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | DC Supply to NIFPS Fail          | Activated=1   |                 | HARDWIRED | From NIFPS                                     |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | Fire Detector Tripped            | Activated=1   |                 | HARDWIRED | From HVWS                                      |
| 220 & 66 kV DBB GIS   | GRID TRANSFORMER | DI               | STATUS                | Online Moisture Removal System   | Healthy       |                 | HARDWIRED | From system panel                              |
| 220 & 66 kV DBB GIS   | BUSPT            | AI               | MEASURING             | R-Y Line Voltage                 |               |                 | HARDWIRED | FROM PT TO TRANSDUCERS IN ECS TRANSDUCER PANEL |
| 220 & 66 kV DBB GIS   | BUSPT            | AI               | MEASURING             | Y-B Line Voltage                 |               |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | BUSPT            | AI               | MEASURING             | R-B Line Voltage                 |               |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | BUSPT            | AI               | MEASURING             | Bus Frequency                    |               |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | BUSPT            | DI               | MEASURING             | Bus PT Primary Side Disconnecter | OPEN          |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | BUSPT            | DI               | MEASURING             | Bus PT Primary Side Disconnecter | CLOSED        |                 | HARDWIRED |                                                |
| 220 & 66 kV DBB GIS   | BUSPT            | DI               | MEASURING             | Bus PT Primary Side Disconnecter | EARTHED       |                 | HARDWIRED |                                                |

| EQUIPMENT DESCRIPTION | FEEDER TYPE                 | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                     | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                                                           |
|-----------------------|-----------------------------|------------------|-----------------------|---------------------------------------------|---------------|-----------------|-----------|-------------------------------------------------------------------|
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | Bus PT Secondary MCB                        | Tripped=1     |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | STAGE 1 UFLS Operated                       | Operated=1    |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | STAGE 2 UFLS Operated                       | Operated=1    |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | STAGE 3 UFLS Operated                       | Operated=1    |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | STAGE 4 UFLS Operated                       | Operated=1    |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | Check Supervision for Bus Differential      | Operated=1    |                 | RELAY LAN |                                                                   |
| 220 & 66 kV DBB GIS   | BUSPT                       | DI               | STATUS                | Differential Protection for Bus             | Operated=1    |                 | RELAY LAN |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | R-Phase Current (Bi-directional)            |               |                 | HARDWIRED | THROUGH MEASURING CT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | Y-Phase Current (Bi-directional)            |               |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | B-Phase Current (Bi-directional)            |               |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | Three Phase Real Power (Bi-directional)     |               |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | Three Phase Reactive Power (Bi-directional) |               |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | Power Factor                                |               |                 | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | CB in Service and                           | Closed        | Open            | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | CB in Service and                           | Open          | Closed          | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 1                                  | Closed        | Open            | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 1                                  | Open          | Closed          | HARDWIRED |                                                                   |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 1 Earth Switch                     | Closed        | Open            | HARDWIRED |                                                                   |

| EQUIPMENT DESCRIPTION | FEEDER TYPE                 | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                          | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                       |
|-----------------------|-----------------------------|------------------|-----------------------|--------------------------------------------------|---------------|-----------------|-----------|-------------------------------|
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 1 Earth Switch                          | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 2                                       | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 2                                       | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 2 Earth Switch                          | Closed        | Open            | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Isolator 2 Earth Switch                          | Open          | Closed          | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Bus Bar Differential                             | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Relay 95B                                        | Operated=1    |                 | RELAY LAN |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Relay 86 - Lock Out Relay                        | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Gas Pressure Low                                 | Operated=1    |                 | HARDWIRED | Separate for each compartment |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | No Voltage Signal from Cap. Voltage Detector - 1 | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | No Voltage Signal from Cap. Voltage Detector - 2 | Operated=1    |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Local Remote Selector Switch                     | Local         |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Local Remote Selector Switch                     | Remote        |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | CB Close Command                                 | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Trip form ECS (TC-1)                             | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Trip from ECS (TC-2)                             | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Close Inhibit (From ECS)                         | Activated=1   |                 | HARDWIRED |                               |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 1 Open Command                          | Activated=1   |                 | HARDWIRED |                               |

| EQUIPMENT DESCRIPTION | FEEDER TYPE                 | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                 | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                |
|-----------------------|-----------------------------|------------------|-----------------------|-----------------------------------------|---------------|-----------------|-----------|------------------------|
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 1 Close Command                | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 1 Earth Switch Open Command    | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 1 Earth Switch Close Command   | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 2 Open Command                 | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 2 Close Command                | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 2 Earth Switch Open Command    | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DO               | COMMAND               | Isolator 2 Earth Switch Close Command   | Activated=1   |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Pole Discordance                        | Operated=1    |                 | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Relay 95 - Trip Circuit - 1 Supervision | Operated=1    |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Relay 95 - Trip Circuit - 2 Supervision | Operated=1    |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Relay 80                                | Operated=1    |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | Numerical Relay                         | Unhealthy=1   |                 | RELAY LAN | For each type of Relay |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | AI               | MEASURING             | MW Value from relay                     | Activated=1   |                 | RELAY LAN |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | AC Control Supply 1                     | Failed        | Healthy         | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | AC Control Supply 2                     | Failed        | Healthy         | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | DC Control Supply 1                     | Failed        | Healthy         | HARDWIRED |                        |
| 220 & 66 kV DBB GIS   | BUS COUPLER / SECTIONALISER | DI               | STATUS                | DC Control Supply 2                     | Failed        | Healthy         | HARDWIRED |                        |
| 6.6 kV AIS            | ISOLATING BKR PNL           | AI               | W                     | 3-Phase Real Power                      |               |                 | RELAY LAN |                        |
| 6.6 kV AIS            | ISOLATING BKR PNL           | AI               | R                     | 3-Phase Reactive Power                  |               |                 | RELAY LAN |                        |
| 6.6 kV AIS            | ISOLATING BKR PNL           | AI               |                       | Power Factor                            |               |                 | RELAY LAN |                        |

| EQUIPMENT DESCRIPTION | FEEDER TYPE          | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION               | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS        |
|-----------------------|----------------------|------------------|-----------------------|---------------------------------------|---------------|-----------------|-----------|----------------|
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Line PT Secondary MCB                 | Tripped=1     |                 | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | S                     | CB in service &                       | Closed        | Not closed      | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | S                     | CB in service &                       | Open          | Not open        | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Relay 86                              | Operated      | Reset           | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Relay 95                              | Operated      | Reset           | RELAY LAN |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Trip on under voltage                 | Activated     | Reset           | RELAY LAN |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Numerical Relay                       | Unhealthy     | Healthy         | RELAY LAN |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DO               | C                     | Trip from ECS                         | Activated     | Reset           | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DO               | COMMAND               | Close Inhibit (From ECS)              | Activated=1   |                 | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Feeder Differential                   | Operated=1    |                 | RELAY LAN |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Transformer Trouble                   | Operated=1    |                 | RELAY LAN | 63TX, 51G, 64R |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Trafo Trouble Alarm (Buch., OTI, WTI) | Operated=1    |                 | RELAY LAN |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | D                     | Trafo Trouble Trip (Buch., OTI, WTI)  | Operated=1    |                 | RELAY LAN |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | STATUS                | AC Control Supply                     | Failed        | Healthy         | HARDWIRED |                |
| 6.6 KV AIS            | ISOLATING BKR PNL    | DI               | STATUS                | DC Control Supply                     | Failed        | Healthy         | HARDWIRED |                |
| 415V SWBD             | Incomer (from trafo) | AI               | A                     | R phase current                       |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | AI               | A                     | Y phase current                       |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | AI               | A                     | B phase current                       |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | AI               | W                     | 3-phase real power                    |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | AI               | R                     | 3-phase reactive power                |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | AI               |                       | Power factor                          |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | DI               | S                     | CB in service & Closed                | Closed        | Not closed      | Hardwired |                |
| 415V SWBD             | Incomer (from trafo) | DI               | S                     | CB in service & Open                  | Open          | Not open        | Hardwired |                |
| 415V SWBD             | Incomer (from trafo) | DO               | C                     | Trip from ECS                         | Activated     | Reset           | Hardwired |                |
| 415V SWBD             | Incomer (from trafo) | DO               | C                     | Close Inhibit (From ECS)              | Operated      | Reset           | Hardwired |                |
| 415V SWBD             | Incomer (from trafo) | DI               | D                     | Relay 95                              | Operated      | Reset           | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | DI               | D                     | Trip on under-voltage                 | Activated     | Reset           | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | DI               | D                     | Numerical Relays                      | Unhealthy     | Healthy         | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | DI               | S                     | Transformer trouble                   | Activated     | Reset           | RELAY LAN |                |
| 415V SWBD             | Incomer (from trafo) | DI               | D                     | Relay 86                              | Operated      | Reset           | Hardwired |                |
| 415V SWBD             | Incomer (from trafo) | DI               | D                     | Over Temperature monitoring system    | Operated      | Reset           | Hardwired |                |
| 415V SWBD             | Line PT I/O signals  | AI               | V                     | R-Y line voltage                      |               |                 | RELAY LAN |                |
| 415V SWBD             | Line PT I/O signals  | AI               | V                     | Y-B line voltage                      |               |                 | RELAY LAN |                |
| 415V SWBD             | Line PT I/O signals  | AI               | V                     | B-R line voltage                      |               |                 | RELAY LAN |                |
| 415V SWBD             | Line PT I/O signals  | DI               | D                     | Line VT MCB                           | Open          | Closed          | Hardwired |                |
| 415V SWBD             | Incomer (other SWBD) | AI               | A                     | R phase current                       |               |                 | RELAY LAN |                |
| 415V SWBD             | Incomer (other SWBD) | AI               | A                     | Y phase current                       |               |                 | RELAY LAN |                |



| EQUIPMENT DESCRIPTION | FEEDER TYPE          | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION             | SET CONDITION       | RESET CONDITION    | INTERFACE | REMARKS |
|-----------------------|----------------------|------------------|-----------------------|-------------------------------------|---------------------|--------------------|-----------|---------|
| 415V SWBD             | Incomer (other SWBD) | AI               | A                     | B phase current                     |                     |                    | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | AI               | W                     | 3-phase real power                  |                     |                    | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | AI               | R                     | 3-phase reactive power              |                     |                    | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | AI               |                       | Power factor                        |                     |                    | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | S                     | CB in service & Closed              | Closed              | Not closed         | Hardwired |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | S                     | CB in service & Open                | Open                | Not open           | Hardwired |         |
| 415V SWBD             | Incomer (other SWBD) | DO               | C                     | Trip from ECS                       | Activated           | Reset              | Hardwired |         |
| 415V SWBD             | Incomer (other SWBD) | DO               | C                     | Close Inhibit (From ECS)            | Operated            | Reset              | Hardwired |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | D                     | Relay 95                            | Operated            | Reset              | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | D                     | Trip on under-voltage               | Activated           | Reset              | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | D                     | Numerical Relay                     | Unhealthy           | Healthy            | RELAY LAN |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | D                     | Relay 86                            | Operated            | Reset              | Hardwired |         |
| 415V SWBD             | Incomer (other SWBD) | DI               | D                     | Over Temperature monitoring system  | Operated            | Reset              | Hardwired |         |
| 415V SWBD             | Bus coupler          | AI               | A                     | R phase current                     |                     |                    | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | AI               | A                     | Y phase current                     |                     |                    | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | AI               | A                     | B phase current                     |                     |                    | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | AI               | W                     | 3-phase Real power                  |                     |                    | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | AI               | R                     | 3-phase Reactive power              |                     |                    | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | AI               |                       | Power factor                        |                     |                    | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | DI               | S                     | CB in service & Closed              | Closed              | Not closed         | Hardwired |         |
| 415V SWBD             | Bus coupler          | DI               | S                     | CB in service & Open                | Open                | Not open           | Hardwired |         |
| 415V SWBD             | Bus coupler          | DO               | C                     | Trip from ECS                       | Activated           | Reset              | Hardwired |         |
| 415V SWBD             | Bus coupler          | DO               | C                     | Close Inhibit (From ECS)            | Operated            | Reset              | Hardwired |         |
| 415V SWBD             | Bus coupler          | DI               | D                     | Relay 95                            | Operated            | Reset              | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | DI               | D                     | Auto-changeover                     | Blocked             | Not blocked        | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | DI               | D                     | Numerical Relay                     | Unhealthy           | Healthy            | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | DI               | D                     | Trip from under voltage             | Activated           | Reset              | RELAY LAN |         |
| 415V SWBD             | Bus coupler          | DI               | S                     | Switchboard (A-I-M selector switch) | In auto mode        | Not in auto mode   | Hardwired |         |
| 415V SWBD             | Bus coupler          | DI               | S                     | Switchboard (A-I-M selector switch) | In independent mode | Not in indep mode  | Hardwired |         |
| 415V SWBD             | Bus coupler          | DI               | S                     | Switchboard (A-I-M selector switch) | In manual mode      | Not in manual mode | Hardwired |         |
| 415V SWBD             | Bus coupler          | DI               | D                     | DC control supply #1                | Failed              | Healthy            | Hardwired |         |
| 415V SWBD             | Bus coupler          | DI               | D                     | DC control supply #2                | Failed              | Healthy            | Hardwired |         |

| EQUIPMENT DESCRIPTION | FEEDER TYPE         | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION    | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS  |
|-----------------------|---------------------|------------------|-----------------------|----------------------------|---------------|-----------------|-----------|----------|
| 415V SWBD             | Bus coupler         | DI               | D                     | AC space heater supply #1  | Failed        | Healthy         | Hardwired |          |
| 415V SWBD             | Bus coupler         | DI               | D                     | AC space heater supply #2  | Failed        | Healthy         | Hardwired |          |
| 415V SWBD             | Bus coupler         | DI               | D                     | Relay 86                   | Operated      | Reset           | Hardwired |          |
| 415V SWBD             | Bus PT              | AI               | V                     | R-Y bus voltage            |               |                 | RELAY LAN |          |
| 415V SWBD             | Bus PT              | AI               | V                     | Y-B bus voltage            |               |                 | RELAY LAN |          |
| 415V SWBD             | Bus PT              | AI               | V                     | B-R bus voltage            |               |                 | RELAY LAN |          |
| 415V SWBD             | Bus PT              | DI               | D                     | Bus PT MCB                 | Open          | Closed          | Hardwired |          |
| 415V SWBD             | Bus PT              | DI               | D                     | UF & df/dt Signal          | Open          | Closed          | Hardwired | 4 Stages |
| 415V SWBD             | Outgoing ACB feeder | AI               | A                     | R phase current            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | AI               | A                     | Y phase current            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | AI               | A                     | B phase current            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | AI               | W                     | Real power                 |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | AI               | R                     | Reactive Power             |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | AI               |                       | Power factor               |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | S                     | CB in service & Closed     | Closed        | Not closed      | Hardwired |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | S                     | CB in service & Open       | Open          | Not open        | Hardwired |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | C                     | Trip from ECS              | Activated     | Reset           | Hardwired |          |
| 415V SWBD             | Outgoing ACB feeder | DO               | C                     | Close Inhibit (From ECS)   | Operated      | Reset           | Hardwired |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | D                     | Relay 95                   | Operated      | Reset           | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | D                     | Numerical Relay            | Unhealthy     | Healthy         | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | D                     | Trip from under voltage    | Activated     | Reset           | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB feeder | DI               | D                     | Relay 86                   | Operated      | Reset           | Hardwired |          |
| 415V SWBD             | Outgoing ACB motor  | AI               | A                     | R phase current            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | AI               | A                     | Y phase current            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | AI               | A                     | B phase current            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | AI               | W                     | Real power                 |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | AI               | R                     | Reactive Power             |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | AI               |                       | Power factor               |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Ready To Close             |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | 49T/50/50LR                |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Earth Fault                |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Unbalance                  |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Under voltage Trip         |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Re-Acceleration            |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Reverse Blocking activated |               |                 | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | Process Trip               | Operated      | Reset           | RELAY LAN |          |
| 415V SWBD             | Outgoing ACB motor  | DI               | S                     | CB in service & Closed     | Closed        | Not closed      | Hardwired |          |

| EQUIPMENT DESCRIPTION | FEEDER TYPE        | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                      | SET CONDITION | RESET CONDITION | INTERFACE | REMARKS                           |
|-----------------------|--------------------|------------------|-----------------------|----------------------------------------------|---------------|-----------------|-----------|-----------------------------------|
| 415V SWBD             | Outgoing ACB motor | DI               | S                     | CB in service & Open                         | Open          | Not open        | Hardwired |                                   |
| 415V SWBD             | Outgoing ACB motor | DI               | S                     | Motor Trip from Process                      | Operated=1    |                 | Hardwired |                                   |
| 415V SWBD             | Outgoing ACB motor | DO               | C                     | Trip from ECS                                | Activated     | Reset           | Hardwired |                                   |
| 415V SWBD             | Outgoing ACB motor | DO               | C                     | Close Inhibit (From ECS)                     | Operated      | Reset           | Hardwired |                                   |
| 415V SWBD             | Outgoing ACB motor | DI               | D                     | Relay 86                                     | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Charger – 1/1                            | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Inverter – 1/1                           | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | S                     | UPS load on Invertor – 1/1                   | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fan Failure - 1/1                        | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fault – 1/1                              | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | AI               | A                     | UPS Current – 1/1                            |               |                 | Hardwired | 4-20mA through transducers in UPS |
| UPS System            | UPS System         | AI               | V                     | UPS Voltage – 1/1                            |               |                 | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Charger – 1/2                            | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Inverter – 1/2                           | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | S                     | UPS load on Invertor – 1/2                   | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fan Failure - 1/2                        | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fault – 1/2                              | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | AI               | A                     | UPS Current – 1/2                            |               |                 | Hardwired | 4-20mA through transducers in UPS |
| UPS System            | UPS System         | AI               | V                     | UPS Voltage – 1/2                            |               |                 | Hardwired |                                   |
| UPS System            | UPS System         | DI               | S                     | UPS load on bypass supply – 1                | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Battery – 1                              | Discharged    | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Battery – 1                              | Isolated      | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Battery Bank Monitoring System Alarm – 1 | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Charger – 2/1                            | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Inverter – 2/1                           | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | S                     | UPS load on Invertor – 2/1                   | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fan Failure - 2/1                        | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fault – 2/1                              | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | AI               | A                     | UPS Current – 2/1                            |               |                 | Hardwired | 4-20mA through transducers in UPS |
| UPS System            | UPS System         | AI               | V                     | UPS Voltage – 2/1                            |               |                 | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Charger – 2/2                            | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Inverter – 2/2                           | Failure       | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | S                     | UPS load on Invertor – 2/2                   | Operated      | Reset           | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fan Failure – 2/2                        | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | DI               | D                     | UPS Fault – 2/2                              | Fault         | Normal          | Hardwired |                                   |
| UPS System            | UPS System         | AI               | A                     | UPS Current – 2/2                            |               |                 | Hardwired | 4-20mA through transducers in     |

| EQUIPMENT DESCRIPTION    | FEEDER TYPE              | INFORMATION TYPE | NATURE OF INFORMATION | INFORMATION DESCRIPTION                      | SET CONDITION  | RESET CONDITION | INTERFACE | REMARKS                   |
|--------------------------|--------------------------|------------------|-----------------------|----------------------------------------------|----------------|-----------------|-----------|---------------------------|
| UPS System               | UPS System               | AI               | V                     | UPS Voltage – 2/2                            |                |                 | Hardwired | UPS                       |
| UPS System               | UPS System               | DI               | S                     | UPS load on bypass supply – 2                | Operated       | Reset           | Hardwired |                           |
| UPS System               | UPS System               | DI               | D                     | UPS Battery – 2                              | Discharged     | Normal          | Hardwired |                           |
| UPS System               | UPS System               | DI               | D                     | UPS Battery – 2                              | Isolated       | Normal          | Hardwired |                           |
| UPS System               | UPS System               | DI               | D                     | UPS Battery Bank Monitoring System Alarm – 2 | Operated       | Reset           | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | DC supply Charger – 1                        | Failure        | Normal          | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | Battery discharged – 1                       | Discharged     | Charged         | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | Battery set Isolated – 1                     | Isolated       | Connected       | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | Charger Boost Charging – 1                   | Boost charging | Float Charging  | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | DC Battery Bank Monitoring System Alarm – 1  | Operated       | Reset           | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | DC Earth Fault relay DCDB Bus – 1            | Failure        | Normal          | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | DC supply Charger – 2                        | Failure        | Normal          | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | Battery discharged – 2                       | Discharged     | Charged         | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | Battery set Isolated – 2                     | Isolated       | Connected       | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | Charger Boost Charging – 2                   | Boost charging | Float Charging  | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | DC Battery Bank Monitoring System Alarm – 2  | Operated       | Reset           | Hardwired |                           |
| DC System                | DC System                | DI               | D                     | DC Earth Fault relay DCDB Bus – 2            | Failure        | Normal          | Hardwired |                           |
| Distribution Transformer | Distribution Transformer | AI               | MEASURING             | Oil Temperature                              |                |                 | HARDWIRED | 4-20mA THROUGH TRAFO MBOX |
| Distribution Transformer | Distribution Transformer | AI               | MEASURING             | Winding Temperature                          |                |                 | HARDWIRED |                           |
| MISC.                    | SOLAR PV                 | DI               | D                     | Building Solar PV System Common Alarm        | Operated       | Reset           | Hardwired |                           |
| MISC.                    | SOLAR PV                 | AI               | A                     | R phase current                              |                |                 | Serial    |                           |
| MISC.                    | SOLAR PV                 | AI               | A                     | Y phase current                              |                |                 | Serial    |                           |
| MISC.                    | SOLAR PV                 | AI               | A                     | B phase current                              |                |                 | Serial    |                           |
| MISC.                    | SOLAR PV                 | AI               | W                     | 3-Phase Real Power                           |                |                 | Serial    |                           |
| MISC.                    | SOLAR PV                 | AI               | R                     | 3-Phase Reactive Power                       |                |                 | Serial    |                           |
| MISC.                    | MISCELLANEOUS            | DO               | COMMAND               | Lighting feeder ' ON'                        | Activated      | Reset           | HARDWIRED |                           |
| MISC.                    | MISCELLANEOUS            | DO               | COMMAND               | Lighting feeder ' OFF'                       | Activated      | Reset           | HARDWIRED |                           |
| MISC.                    | MISCELLANEOUS            | DO               | COMMAND               | Load Shedding                                | Operated       | Reset           | HARDWIRED |                           |
| MISC.                    | MISCELLANEOUS            | DI               | STATUS                | SAS Ethernet Switch Power Supply Fail        | Failure        | Normal          | HARDWIRED |                           |
| MISC.                    | HVAC                     | DI               | D                     | Building VAM System Common Alarm             | Operated       | Reset           | Hardwired |                           |

| EQUIPMENT<br>DESCRIPTION | FEEDER TYPE | INFORMATION<br>TYPE | NATURE OF<br>INFORMATION | INFORMATION<br>DESCRIPTION                                                               | SET<br>CONDITION | RESET<br>CONDITION | INTERFACE | REMARKS                                    |
|--------------------------|-------------|---------------------|--------------------------|------------------------------------------------------------------------------------------|------------------|--------------------|-----------|--------------------------------------------|
| MISC.                    | HVAC        | AI                  | T                        | Switchgear Hall / Battery Charger Room / UPS<br>Room / VFD Room Temperature individually |                  |                    | Hardwired | 4-20mA through transducers/<br>transmitter |

**MANDATORY SPARE LIST**  
**(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**

| F       | 13.05.2022 | REVISED & REISSUED WITH TENDER   | MKM         | RG         | HK          |
|---------|------------|----------------------------------|-------------|------------|-------------|
| E       | 07.04.2022 | REVISED AND REISSUED WITH TENDER | MKM         | RG         | HK          |
| D       | 01.04.2022 | REVISED AND REISSUED WITH TENDER | MKM         | RG         | HK          |
| C       | 27.09.2021 | REVISED AND REISSUED WITH TENDER | AKG         | HK         | HK          |
| B       | 05.07.2021 | REVISED AND REISSUED WITH TENDER | AKG         | HK         | HK          |
| Rev. No | Date       | Purpose                          | Prepared by | Checked by | Approved by |



Mandatory spares for applicable items shall be as per Clause 6.1 of Engineering Design Basis (Electrical), B269-999-16-50-EDB-1001 attached with the tender document.

In addition to the above following mandatory spare shall also be supplied:

As per bid price schedule

| Sr. No    | PART DESCRIPTION                                                        | QUANTITY REQUIRED                                                                                             |
|-----------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <b>1.</b> | <b>EHV GIS with LCP and CRP</b>                                         | <b>One set of spare for each GIS, LCP and CRP (Separate, wherever applicable)</b>                             |
| 1.1.      | SF <sub>6</sub> Gas Leakage Detector                                    | 1 Nos. ** (Note-8)                                                                                            |
| 1.2.      | SF <sub>6</sub> Gas Analyzer                                            | 1 Nos. ** (Note-8)                                                                                            |
| 1.3.      | Portable Partial Discharge Monitoring System                            | 1 Nos. ** (Note-8)                                                                                            |
| 1.4.      | Online Partial Discharge(PD) monitoring system for indoor & outdoor GIS | 1 Nos. * (Note-7)                                                                                             |
| 1.5.      | SF6 online topping system / Online SF6 Gas filling system               | 1 Nos. ** (Note-8)                                                                                            |
| 1.6.      | Gas Filling and Evacuation Cart                                         | 1 Nos. ** (Note-8)                                                                                            |
| <b>2.</b> | <b>Power Transformer</b>                                                | <b>One set of spare for all power transformer</b>                                                             |
| 2.1.      | Dissolved Gas Analysis kit                                              | 2 Nos. — Refer clause 5.1.11 of electrical job specification                                                  |
| 2.2.      | Online Moisture Removal System— Filters                                 | 10% or minimum 2 Nos. of each type & rating                                                                   |
| 2.3.      | Online Moisture Removal System— Cartridges                              | 10% or minimum 2 Nos. of each type & rating                                                                   |
| <b>3.</b> | <b>6.6kV Air Insulated Switchboard (AIS)</b>                            | <b>One set of spare common for AIS IBPs</b>                                                                   |
| 3.1.      | Ethernet Switch for 6.6 kV AIS IBP                                      | 1 Nos. (Each type)                                                                                            |
| <b>4.</b> | <b>415V PMCC/ MV Switchboard</b>                                        | <b>One set of spare for each switchboard</b>                                                                  |
| 4.1.      | Ethernet switch for 415V PMCC                                           | 1 Nos.                                                                                                        |
| <b>5.</b> | <b>Relay control Panel</b>                                              | <b>One set of spare each for 220 kV GIS Relay &amp; Control panel and 66 kV GIS Relay &amp; Control panel</b> |
| 5.1.      | Ethernet switch for GIS Control and Relay Panel                         | 1 Nos.                                                                                                        |
| <b>6.</b> | <b>Solar Photovoltaic System</b>                                        | <b>One set of spare for each system</b>                                                                       |
| 6.1.      | Power Thyristor / Transistors / IGBT / IGCT                             | 1 No. of each rating & type                                                                                   |
| 6.2.      | Control cards                                                           | 1 No. of each type                                                                                            |

| Sr. No | PART DESCRIPTION            | QUANTITY REQUIRED                            |
|--------|-----------------------------|----------------------------------------------|
| 6.3.   | Power supply cards          | 1 No. of each rating and type                |
| 6.4.   | Cable connectors            | 10% or minimum 2 Nos. of each type           |
| 7.     | <b>415V Fixed Type PDBs</b> | <b>One set of spare for each switchboard</b> |
| 7.1.   | Control fuses               | 10 Nos. each rating & type                   |
| 7.2.   | Indicating lamps covers     | 5 Nos. of each colour                        |
| 7.3.   | Indicating lamps            | 20% or 3 Nos. (min.), whichever is more      |

NOTES:

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. The terminology used under 'Item Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
3. Wherever % age is identified, Contractor shall supply next rounded figure.
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 sub-packages as per mandatory spares philosophy specified elsewhere in the bid document.
7. \* 1 no. of each item for each EHV GIS i.e. separate set for 220kV indoor GIS, & 66kV indoor GIS.
8. \*\* 1 no. of each item for MRSS-100 (i.e. common set for 220kV & 66kV Indoor GIS)

# **GENERAL NOTES**

## **FOR**

### **CABLING SYSTEM**

**PROJECT** : PANIPAT REFINERY EXPANSION (P-25) PROJECT

**CLIENT** : M/s IOCL

**LOCATION** : PANIPAT, HARYANA, INDIA

**CONSULTANT** : ENGINEERS INDIA LIMITED

**JOB NO.** : B269

## **GENERAL NOTES: CABLING SYSTEM**

1. The cabling system shall be executed in accordance with the requirements laid down in EIL Specification 6-51-0082, respective installation standards, cable schedules, General Notes Lighting, General Notes Earthing & Lightning Protection, applicable BIS codes & standards, CEA Regulations and other statutory regulations, specific job requirement indicated in this document and the respective cable layout drawings.
2. In case of any contradiction between various referred standards / documents / statutory regulations the following order of priority shall govern
  - Statutory regulations
  - Cable layout drawing(s)
  - This specification
  - Installation standards
  - Standard specification
  - Codes and standardsHowever, concurrence of Engineer-in Charge shall always be obtained, before taking a final decision in any such matter.
3. It shall be Contractor's responsibility to coordinate with other agencies associated with project for smooth execution of work.
4. All cable trays shall be supported @ 3 m / @ 2m intervals along straight run (as specified in layout drawing) & vertical dropping of trays shall be supported generally @2m intervals. For exact location/ elevation of the electrical cable tray supports, refer respective structural drawings.
5. Electrical contractor shall provide cable tray supports (both vertical and horizontal) inside the substation cellar. Vertical supports shall be welded to MS insert plates provided by structural contractor. Wherever these insert plates are not available, electrical contractor shall provide required insert plates, insert angles, using anchor fasteners.
6. All cable tray supports on pipe rack/cable rack shall be provided by structural contractor as per respective structural drawings.
7. In general, HV cables and MV Power & control cables shall be laid in separate trays, unless otherwise indicated in the drawing. Wherever HV & MV cables are laid in the same tray, suitable barrier plates shall be provided between HV & MV cables with minimum spacing of 300 mm between HV & MV cables.
8. Plant communication, fire alarm & telephone cables and Optical Fibre Cables (OFC) in HDPE conduit, shall be laid in instrumentation overhead cable duct / instrumentation trenches as far possible. In other areas, these cables shall be laid in electrical routes, along berm of the roads, or separately in a suitable polyolefin injection moulded underground cable duct/ pre-cast RCC trench.
9. All tray bends shall have uniform bending radius of 1000/ 1600/ 2000mm (as specified in the layout drawings). At any particular location all vertical outside/ inside bends shall have uniform bending radius i.e. 1000/ 1600/ 2000mm based on bending radius governed by 66kV cable tray at that route.
10. After completion of laying of cables, all cables/ cable tray entries in substation/ other buildings (except process control room/ rack rooms) shall be suitably sealed with weatherproof compound to prevent water and entry of rodent/ creepers. MCTs shall be provided for cable entries to process control room/ rack room and shall have 20% spare provision for future use.
11. Cable trays, racks and trenches shall be sized to allow for 20 % space for future cables.

12. Jointing of prefabricated ladder type cable trays and their fittings shall be done by using splice plates. Splice plates shall be provided, one on inside face and one on outside face, of each side runner of cable tray, at each joint.
13. RCC cable trenches other than those of 220kV cable trenches shall be filled with stone dust / fine river sand.
14. No cable trays/racks to be provided in RCC lined trenches other than those of 220kV cables trenches.
15. In case of vehicular traffic over the RCC cable trench, the same shall be of heavy duty construction suitable for vehicular movement.
16. Street lighting cables shall not be laid along with fire alarm, communication and telephone cables. These cables shall be laid in separate buried cable trench in road berm or in suitable polyolefin injection moulded underground cable duct.
17. Perforated trays shall be used to run power cable of welding receptacles from the nearest main tray/ G.I. sleeves.
18. Perforated trays shall be used to run lighting cables. Routing of the same shall be decided suitably at site.
19. Walkways shall be provided on either side of overhead cable trays on pipe racks (with ladders at regular intervals) to facilitate movement of people while pulling cable
20. Cable trays shall be Hot dip Galvanized(HDG) prefabricated.
21. Underground 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 160mm PVC/RCC pipes may be provided. The ERC shall have minimum 30% spare pipes. The pipes shall be embedded in concrete. Minimum 6 nos. 160mm pipes shall be provided in ERC at any road crossing.
22. Overhead Road crossings shall be provided with overhead cable bridge.
23. All single core cables (220kV, 66kV & 33kV) shall be laid in trefoil formation except for short run of cables within substations. Single core cables pertaining to 3-phase circuits shall be laid together & separated from multi-core cables as per requirements specified in IS-1255. Trefoil formation shall be braced by suitable clamps including necessary hardware for fixing the cables at a distance not exceeding 3m for 33kV cables and 800mm for 66kV & 220kV Cables.
24. For 220kV & 66kV Single core cables, bonding arrangement (single point/ midpoint/ cross) shall be as per respective cable manufacturer recommendation which shall be provided during detail engineering. Surge voltage limiters (SVLs) shall also be installed as per respective cable manufacturer recommendation.
25. For 33kV Single core cables, bonding of armour and screen shall be as per cable manufacturer recommendation which shall be finalised during detail engineering.
26. Cutouts on both sides of panels (for future use) shall be covered by 6.0 mm thick chequered plates.
27. MS angle cleats shall be welded to the horizontal support at the end of the cable trays.
28. Cables in general shall be laid in RCC trench, stone dust/ sand filled in Process area. Cable laying in offsite area shall be through above ground cable tray on sleeper for paved area and through above ground cable tray/ RCC cable trench and directly buried & laid in underground duct/ pre-cast RCC trench for unpaved area.
29. No process pipe shall pass through cable trench. If unavoidable, min. 300mm clearance to be provided between pipe and cables. In this case, either pipe or cable trench shall be taken through RCC congregate.
30. Care to be taken so that no hydrocarbon seepage in the cable trench takes place. Also the precast RCC cover should be such that no oil/ seepage is allowed into the trench.
31. 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.

32. All power cables inside battery room from battery charger onwards shall be provided with fire proof coating as per IEC-60331.
33. 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.
34. Sealing compound shall be used for sealing metallic kick pipes
35. Trenches shall be marked at all direction changes, intersections and straight runs.
36. All hardware used for joining cable trays shall be of SS material.
37. Cables shall not pass through area where high temperature lines, steam vents / drains etc are provided. However, adequate precautions shall be taken if un-avoidable in some cases.
38. Electrical cable layout drawing gives indicative route of trays/ trenches. For exact coordinates of these, Piping / General Civil area drawings of respective area shall be referred.
39. Unless otherwise specified, tray levels given in the drawing shall correspond to the bottom level of tray.
40. For co-ordinates of directly buried trenches/ underground duct, RCC trenches, ERCs, CTCs & SCRCs etc. respective General Civil / piping area drawings shall be referred.
41. The dimensions shown for the cable trenches on the respective cable layout drawings are the clear dimensions. Details of trenches (i.e. thickness of wall/ bricks/ slab) shall be as per respective Structural Standards.
42. Exact termination / layout of G.I. Pipes (for protection of cables) shall be suitably decided at site depending upon the location of respective terminal block of the electrical equipment.
43. The G.I./ PVC sleeves shall be adjusted suitably at site during installation to avoid fouling with any underground equipments, pipes, foundations, etc.
44. Edges of cable trenches and cover slabs shall be provided with structured steel angles for nosing protection.
45. Where fire proofing columns/ structures are encountered, socket, receptacle, cable trays, lighting fixtures, etc. shall be installed on a suitable deep legged angle iron frame/ distance bracket.



# GENERAL NOTES

## FOR

### EARTHING AND LIGHTNING PROTECTION SYSTEM

**PROJECT** : PANIPAT REFINERY EXPANSION (P-25) PROJECT

**CLIENT** : M/s IOCL

**LOCATION** : PANIPAT

**CONSULTANT** : ENGINEERS INDIA LIMITED

**JOB NO.** : B269

|         |            |                         |             |            |             |
|---------|------------|-------------------------|-------------|------------|-------------|
|         |            |                         |             |            |             |
|         |            |                         |             |            |             |
|         |            |                         |             |            |             |
| 0       | 04.04.2022 | ISSUED FOR CONSTRUCTION | AK          | MK         | HK          |
| Rev. No | Date       | Purpose                 | Prepared by | Checked by | Approved by |

## **GENERAL NOTES: EARTHING AND LIGHTNING PROTECTION SYSTEM**

1. Earthing and lightning protection system works shall be executed in accordance with EIL Specification 6-51-0084, EIL standard 7-51-0116 for equipment earthing schedule, EIL installation standards referred in the layout drawings, specific job requirement indicated in this document and the respective earthing and lightning protection layout drawings.
2. In case of any contradiction between various referred standards / documents / statutory regulations the following order of priority shall govern
  - Statutory regulations
  - Earthing & Lighting Protection drawing(s)
  - This specification
  - Installation standards
  - Standard specification
  - Codes and standards

However, concurrence of Engineer-in Charge shall always be obtained, before taking a decision in any such matter.

3. It shall be Contractor's responsibility to coordinate with other agencies associated with project for smooth execution of work.
4. All panels/cabinets, steel frames, field control box, junction box, special instruments etc. will be connected to the earth, the connection shall be according to respective layout drawings and standards, job specification for earthing.
5. Earth bonding to the ladder, any metal parts and staircase shall be according to respective layout drawings and standards, job specification for earthing.
6. All earth pits (both earthing & lightning protection) shall be maintenance free chemical earth pits with Cu bonded high tensile low carbon steel core electrode
7. Unless otherwise specified, 100 X 12 mm G.I. earth strip shall be used for substations/ SRR/ CR/ MCR and 50 X 6 mm G.I. earth strip shall be used in process units and offsite area as main earth grid conductor.
8. Street lighting poles / high masts shall be earthed to the main earth grid, wherever available nearby, else separate 50 x 6 mm GI strip will be run for the street lighting system and shall be connected to main grid at minimum two points.
9. All lighting fixtures and single phase sockets shall be earthed using the third core of the feeding cable or third wire in circuit wiring as per respective lighting layout drawing.
10. The KW rating of motors, wherever indicated in the layout drawing is for guidance only. Selection of earthing conductor shall be done based on exact rating as per respective motor's nameplate.
11. In hazardous areas, all process equipment shall be connected to the earth grid at minimum two points. Pipelines shall be earthed at entry and exit of battery limit of process units as per EIL standard 7-51-0112. The earthing conductors shall be as per earthing layout drawings/ equipment earthing schedule 7-51-0116.
12. Reinforcement bars of pipe rack concrete column / pavement shall be connected to the main earth grid by using 50 x 6 mm GI strip at interval of not more than 24 m.
13. Tall columns as per layout drawing having continuous metallic structure shall be earthed at minimum 2 points at its bottom and shall be directly connected to individual earth electrodes for lightning protection.

14. Technological structure, vessels, columns shall be earthed minimum at two points, preferably diagonally opposite. The earthing conductors shall be as per earthing layout drawings/ equipment earthing schedule 7-51-0116.
15. Earth strip, wherever shown on platforms, shall be cleated below the platform.
16. Tappings from main grid upto the earth plate shall generally be of the same size as the main earth grid.
17. Reinforcement bars of extreme columns of sub-station building, reinforcement bars in ground and first floor slab of sub-station building shall be effectively earthed using 100 x 12 mm GI strip.
18. Lightning protection grid for buildings and sheds (wherever indicated) shall be formed by using 25x3mm G.I. strip suitably cleated along parapet wall / roof.
19. Earthing of transformer neutrals shall be done using two independent earth electrodes, as per standard / job specification, CEA guidelines. Their electrodes shall be interconnected to main earth grid.
20. Clean earth system for instrumentation shall be separate from electrical earthing grid.
21. Common clean earth shall be provided for relays, VFD PLC, Thyristor & SAS separate from substation earthing system
22. All equipment shall be earthed using GI wire ropes/ G.I. earth strip. The conductor size/type to be used for earth connection of various equipments shall be as per the equipment earthing schedule (EIL Standard No. 7-51-0116).
23. Earth pit cover shall be of chequered plate.

**TECHNICAL AMENDMENT NO: 01**  
**TO**  
**TENDER:B269-999-16-50-EB-T-0020FOR 220KV GIS PACKAGE**  
**(PROJECT:P-25,M/s IOCL-PANIPAT)**

|          |                   |    |         |          |
|----------|-------------------|----|---------|----------|
|          |                   |    |         |          |
| 17.05.22 | Issued for tender | SS | GJK     | SD       |
| DATE     | PURPOSE           | BY | CHECKED | APPROVED |

**SUBJECT** : **Technical Amendment No.: 01**  
**TENDER NO.** : **B269-999-16-50-EB-T-0020**

The terms, conditions and specifications of Bidding Document stand modified to the extent indicated under column "MODIFICATIONS/ADDITION/DELETION". Corresponding implications of the same, else-where in the bid package shall be taken care appropriately. All other terms & conditions, stipulations and specifications of Bidding Document shall remain unaltered.

| S.No | Section No./ Document No.                                | Clause No./ Item No.                                                                   | Subject                                               | Modifications / Additions/Deletions/ Clarification                                                                                 |
|------|----------------------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | B269-000-81-41-02406                                     | Clause no 4, S. NO. B " CIVIL/ STRUCTURAL/ ARCHITECTURAL " of MASTER LIST OF DOCUMENTS | Substation – 220 KV GIS – Ground Floor Plan           | The drawing no. "B269-000-81-41-02406 Revision B " Shall be REPLACED with attached drawing no. "B269-000-81-41-02406 Revision C ". |
| 2.   | B269-000-81-41-02407                                     | - DO -                                                                                 | Substation – 220 KV GIS – First Floor Plan & Section  | The drawing no. "B269-000-81-41-02407 Revision B " Shall be REPLACED with attached drawing no. "B269-000-81-41-02407 Revision C ". |
| 3.   | B269-000-81-41-02408                                     | - DO -                                                                                 | Substation – 220 KV GIS – Second Floor Plan & Section | The drawing no. "B269-000-81-41-02408 Revision B " Shall be REPLACED with attached drawing no. "B269-000-81-41-02408 Revision C ". |
| 4.   | B269-000-81-41-02511                                     | - DO -                                                                                 | Switchyard Substation – Plan & Section                | The drawing no. "B269-000-81-41-02511 Revision A " Shall STAND DELETED.                                                            |
| 5.   | PART-A (ARCHITECTURAL) / B269-999-81-41-SOW-0020 (Rev B) | Clause no. 1.1.1 (b)/ DETAILED SCOPE OF WORK                                           | Switch Yard Substation                                | "Switch Yard Substation in existing Panipat Refinery " Shall STAND DELETED.                                                        |

(SIGNATURE AND STAMP OF BIDDER)

**SUBJECT: 220kv GIS Package**

**BIDDING DOCUMENT NO.: B269-999-16-50-EB-T-0020**

The terms, conditions of Bidding Documents and modified to the extent indicated under column "MODIFICATIONS/ADDITIONS/ DELETIONS". All other terms & conditions etc. of bidding Document issued earlier shall remain unaltered.

**B. STRUCTURAL**

| S.No | Section<br>(Document No )                                                   | Subject/Clause No                                                                                                                                                                                                                                                                                                             | Modifications/Additions/Deletions                                                                                                                                                                                                                                                                                                        |
|------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | B269-999-81-41-SOW-0020 Rev.B<br>Clause No.1.0, Page No.7 of 16             | The Scope of Civil and Structural works under this contract shall include design, detailing, supply and construction of all relevant civil and steel works required for successful completion of works for 220kV Gas Insulated Substation (GIS) building and Switchyard as per specifications enclosed with the Bid document. | <b>Modifications:-</b><br>The Scope of Civil and Structural works under this contract shall include design, detailing, supply and construction of all relevant civil and steel works required for successful completion of works for 220kV Gas Insulated Substation (GIS) building as per specifications enclosed with the Bid document. |
| 2    | B269-999-81-41-SOW-0020 Rev.B<br>Clause No.1.0, S.no. a. v, Page No.7 of 16 | Foundation & Super-structure of All Switch Yard Structures (Gantry Tower, Lightning Arrestors, Cable Termination, Bus Post Insulators etc.), Equipment and support structure for GIS Bus, Operating and Maintenance Platform, Architectural sheeting & Ventilation works whatsoever required within Battery Limit area.       | <b>Modifications:-</b><br>Foundation & Super-structure of Equipment and support structure for GIS Bus, Operating and Maintenance Platform, Architectural sheeting & Ventilation works, Foundations for Power and Distribution Transformer etc. whatsoever required within Battery Limit area.                                            |

| A      | 11.05.2022 | ISSUED FOR BIDS | MK          | KML        | PM          |
|--------|------------|-----------------|-------------|------------|-------------|
| Rev.No | Date       | Purpose         | Prepared by | Checked by | Approved by |



| S.No | Section<br>(Document No )                                                   | Subject/Clause No                                                                                                                   | Modifications/Additions/Deletions                     |
|------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| 3.   | B269-999-81-41-SOW-0020 Rev.B<br>Clause No.2.0, S.no. i, Page No.9<br>of 16 | Min. thickness of various structural steel<br>components for transmission tower and switchyard<br>structures shall be as per IS:802 | <b>Modifications:-</b><br>This clause stands deleted. |

We accept all the modifications, additions, deletions of Technical amendment 02 in totality and our quoted price is inclusive of above

Name of Bidder:

Seal / Stamp:

| A      | 11.05.2022 | ISSUED FOR BIDS | MK             | KML           | PM             |
|--------|------------|-----------------|----------------|---------------|----------------|
| Rev.No | Date       | Purpose         | Prepared<br>by | Checked<br>by | Approved<br>by |

TECHNICAL AMENDMENT  
(Static & Machinery Equipment)  
FOR  
220 kV GIS PACKAGE

**TECHNICAL AMENDMENT No. 2**

ITEM DESCRIPTION:

220 kV GIS PACKAGE

TENDER NO. :

B269-999-16-50-EB-T-0020

| 0        | 11/05/2022 | ISSUED AS AMENDMENT TO TENDER | BKD         | AK/AN      | SPC         |
|----------|------------|-------------------------------|-------------|------------|-------------|
| Rev. No. | Date       | Purpose                       | Prepared By | Checked By | Approved By |

**TECHNICAL AMENDMENT  
(Static & Machinery Equipment)  
FOR  
220 kV GIS PACKAGE**

The terms, conditions and specifications of Bidding Document stand modified to the extent indicated under column "MODIFICATIONS/ADDITION/DELETION". All other terms & conditions, stipulations and specifications of bidding document shall remain unaltered.

| S. No. | Part No/ Vol. No | Page No/ Document No.                            | Document Title                                        | Section/ Clause No. | Subject               | Clarification/Modifications / Additions / Deletion                                                                                                                         |
|--------|------------------|--------------------------------------------------|-------------------------------------------------------|---------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.     | Technical        | Page no.: 3 of 6 / B269-999-80-43-SOW-0020 Rev 2 | Scope of Work / Supply (Static & Machinery equipment) | Cl. No. 1.2         | Scope of Work /Supply | <b>Deletion :</b><br>Clause no.1.2 related to Package AC system for Sub-station ( switchyard) stands deleted.                                                              |
| 2.     | Technical        | Page no.: 4 of 6 / B269-999-80-43-SOW-0020 Rev 2 | Scope of Work / Supply (Static & Machinery equipment) | Cl. No. 3.2         | Scope of Work /Supply | <b>Deletion :</b><br>Clause no.3.2 related to Chain Pulley Block for loading/ unloading of switch gear panels from first floor of Sub-station (Switchyard) stands deleted. |
| 3.     | Technical        | Page no. 4 of 21/ B269-999-80-43-SP-0020 Rev 2   | Job Specification (Static & Machinery equipment)      | Cl. No. 3.1.5.1     | Job Specification     | <b>Deletion :</b><br>Clause no. 3.1.5.1, outdoor(fresh air) requirement for switchgear room (switchyard) stands deleted.                                                   |
| 4.     | Technical        | Page no. 5 of 21/ B269-999-80-43-SP-0020 Rev 2   | Job Specification (Static & Machinery equipment)      | Cl. No. 3.1.5.2     | Job Specification     | <b>Deletion :</b><br>Clause no. 3.1.5.2, equipment load, occupancy details given on this page for Sub-station (switchyard) stands deleted.                                 |
| 5.     | Technical        | Page no. 6 of 21/ B269-999-80-43-SP-0020 Rev 2   | Job Specification (Static & Machinery equipment)      | Cl. No. 3.1.7       | Job Specification     | <b>Deletion :</b><br>Clause no. 3.1.7. (ii).b i "water cooled package AC for substation (switch yard) building" stands deleted.                                            |
| 6.     | Technical        | Page no. 8 of 21/ B269-999-80-43-SP-0020 Rev 2   | Job Specification (Static & Machinery equipment)      | Cl. No. 3.1.9       | Job Specification     | <b>Deletion :</b><br>Clause no. 3.1.9 i "Configuration of Air conditioning system with water cooled package AC" stands deleted.                                            |

**TECHNICAL AMENDMENT**  
**(Static & Machinery Equipment)**  
**FOR**  
**220 kV GIS PACKAGE**

| S. No. | Part No/ Vol. No | Page No/ Document No.                           | Document Title                                             | Section/ Clause No.      | Subject                                            | Clarification/Modifications / Additions / Deletion                                                                     |
|--------|------------------|-------------------------------------------------|------------------------------------------------------------|--------------------------|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 7.     | Technical        | Page no. 11 of 21/ B269-999-80-43-SP-0020 Rev 2 | Job Specification (Static & Machinery equipment)           | Cl. No. 3.1.10           | Job Specification                                  | <b>Deletion :</b><br>Clauseno.3.1.10i The words "SUBSTATION(SWITCHYARD)" stands deleted.                               |
| 8.     | Technical        | B269-999-80-42-DS-0020-10 Rev 0                 | Data Sheet for Water/ Cooled Packaged Unit (For AC System) | -                        | Data Sheet of Water Cooled Package Air-Conditioner | <b>Deletion:</b><br>Data Sheet of Water Cooled Package Air-Conditioner stand deleted.                                  |
| 9.     | Technical        | B269-999-80-43-SP-0020 Rev 2                    | Job Specification (Static & Machinery equipment)           | Cl. 3.1.1, 3.2.1 & 3.3.1 | Sub vendor list                                    | <b>Addition:</b><br>Sub vendor list for HVAC-Central air conditioning, EOT Crane (safe area) and CP block is enclosed. |

Enclosure:

1. Sub Vendor list for HVAC-Central air conditioning, EOT Crane (safe area) and CP block (Doc. no. B269-999-80-42-VL-0020)

| Sr No              | Supplier Code | Supplier Name                                       | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------------------|---------|---------------------|
| Item Code : 06AA   |               | Description : HVAC SYSTEM- CENTRAL AIR CONDITIONING |         |                     |
| Approved Suppliers |               |                                                     |         |                     |
| 1                  | 3678          | ROOTS COOLING SYSTEMS PVT. LTD.                     | INDIA   |                     |
| 2                  | B029          | BLUE STAR LTD                                       | INDIA   |                     |
| 3                  | E178          | VERTIV ENERGY PRIVATE LIMITED                       | INDIA   |                     |
| 4                  | A336          | ADVANCE VENTILATION PVT. LTD                        | INDIA   |                     |
| 5                  | 3962          | ANEMO PROJECTS PVT LTD                              | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                       | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------------------|---------|---------------------|
| Item Code : 07AC   |               | Description : CRANE- E.O.T (SAFE AREA)              |         |                     |
| Approved Suppliers |               |                                                     |         |                     |
| 1                  | G183          | GRIP ENGINEERS PVT.LTD                              | INDIA   |                     |
| 2                  | C035          | CONSOLIDATED HOISTS PVT LTD.                        | INDIA   |                     |
| 3                  | T222          | TATA STEEL GROWTH SHOP                              | INDIA   |                     |
| 4                  | 3875          | MEEKA MACHINERY PVT LTD                             | INDIA   |                     |
| 5                  | 3622          | UNIQUE INDUSTRIAL HANDLERS PVT. LTD.                | INDIA   |                     |
| 6                  | 3619          | TECHNO INDUSTRIES                                   | INDIA   |                     |
| 7                  | 3620          | TECHNO INDUSTRIES                                   | INDIA   |                     |
| 8                  | E227          | ELECTROMECH MATERIAL HANDLING SYSTEMS (I) PVT. LTD. | INDIA   |                     |
| 9                  | A266          | ANUPAM INDUSTRIES LIMITED (ANAND)                   | INDIA   |                     |
| 10                 | W005          | BRADY & MORRIS ENGINEERING CO. LTD.                 | INDIA   |                     |
| 11                 | S138          | SAFEX ENERGY PVT LTD                                | INDIA   |                     |
| 12                 | H012          | HEAVY ENGINEERING CORPORATION LTD                   | INDIA   |                     |
| 13                 | M248          | MEEKA MACHINERY PVT LTD                             | INDIA   |                     |
| 14                 | E072          | EDDY CRANES ENGRS (P) LTD                           | INDIA   |                     |
| 15                 | F023          | FURNACE AND FOUNDRY EQUIPMENT CO.                   | INDIA   |                     |
| 16                 | S377          | SAFEX ELECTROMECH PVT LTD                           | INDIA   |                     |
| 17                 | S853          | STAHL CRANE SYSTEMS GMBH                            | GERMANY |                     |
| 18                 | W013          | KONECRANES AND DEMAG PRIVATE LIMITED                | INDIA   |                     |

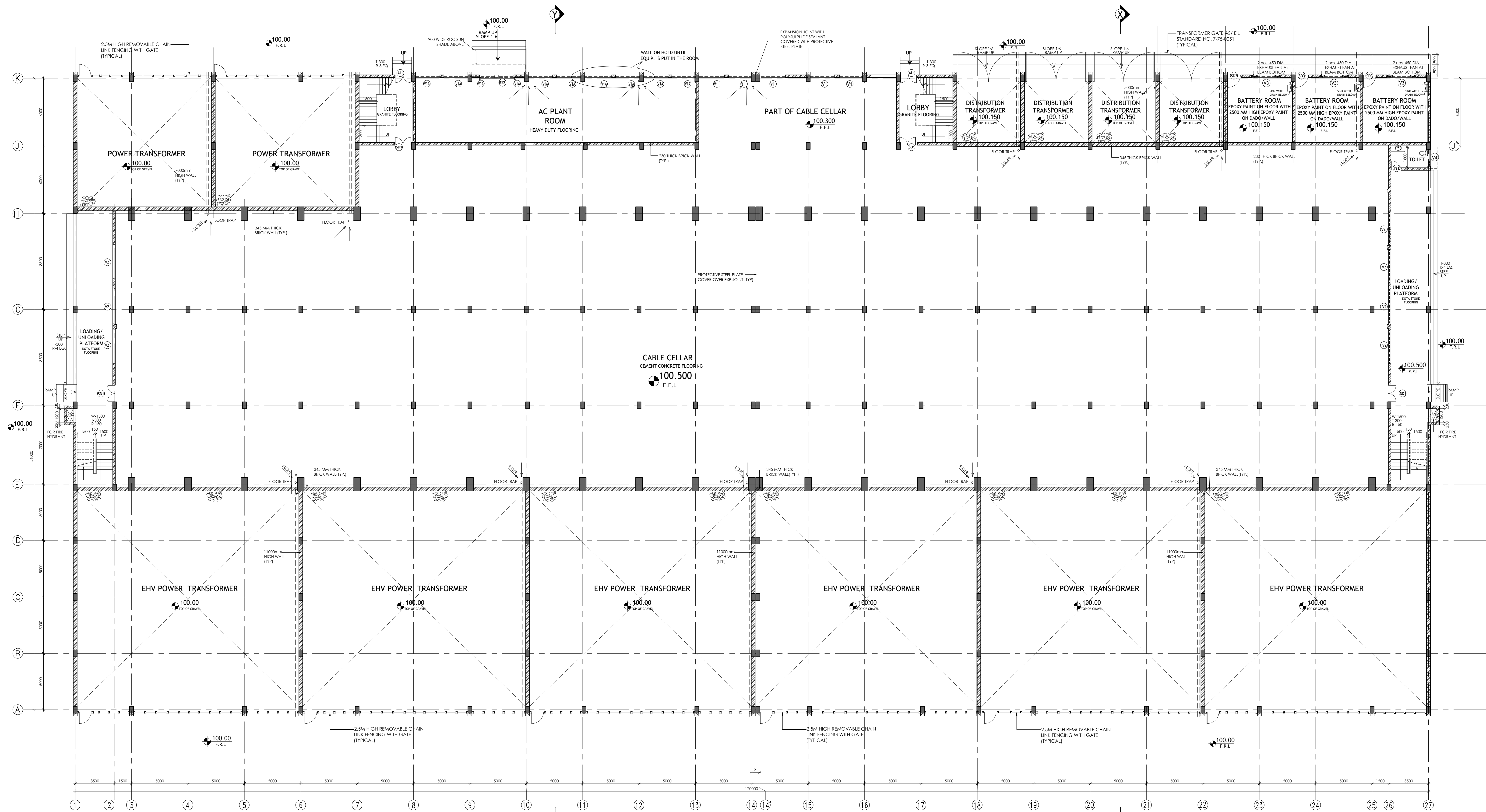
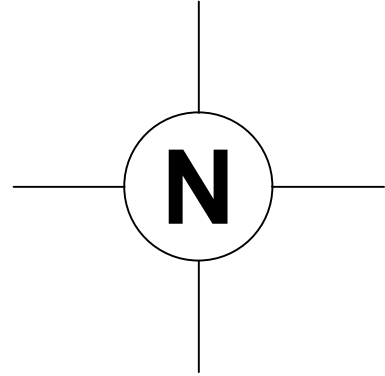


| Sr No              | Supplier Code | Supplier Name                       | Country | Holiday Description |
|--------------------|---------------|-------------------------------------|---------|---------------------|
| Item Code : 07AH   |               | Description : CHAIN PULLEY BLOCK    |         |                     |
| Approved Suppliers |               |                                     |         |                     |
| 1                  | 3921          | BAKELITE ELECTRICAL MFG CO.PVT LTD  | INDIA   |                     |
| 2                  | W005          | BRADY & MORRIS ENGINEERING CO. LTD. | INDIA   |                     |
| 3                  | H129          | HERCULES HOISTS LTD                 | INDIA   |                     |



065053055054





## GROUND FLOOR PLAN

| REF. DWG. NO.        | REFERENCE DRAWING TITLE                     |
|----------------------|---------------------------------------------|
| B269-000-81-41-02407 | SUBSTATION-100: FIRST FLOOR PLAN IN SECTION |
| B269-000-81-41-02408 | SUBSTATION-100: SECOND FLOOR PLAN & SECTION |

| NOTES :-                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. ALL DIMENSIONS ARE IN MILLIMETRES.                                                                                                                                                                                                              |
| 2. ALL LEVELS ARE IN METRES.                                                                                                                                                                                                                       |
| 3. LEVEL 100.00 INDICATES FINISHED APPROX. GRADE<br>NEAR THE BUILDING.                                                                                                                                                                             |
| 4. UNDERFLOOR INSULATION SHALL BE PROVIDED UNDER THE ROOF<br>OF ALL AC AREAS AND A.H.U. ROOM.                                                                                                                                                      |
| 5. ALL OUTSIDE SURFACES SHALL BE FINISHED WITH 18MM. THK.<br>PLAIN CEMENT PLASTER ON BRICK SURFACES & 6MM. THK.<br>PLUM CEMENT PLASTER ON R.C.C. SURFACES, EXCEPT WHERE<br>SAND FACE PLASTER IS MENTIONED.                                         |
| 6. ALL INTERNAL WALLS SHALL BE FINISHED WITH 12MM THK.<br>PLUM CEMENT PLASTER ON R.C.C. SURFACES & 12MM/15MM<br>THK. PLAIN CM. PLASTER ON EITHER SIDE OF INTERNAL WALLS.<br>6MM THK. PLAIN CEMENT PLASTER SHALL BE PROVIDED ON<br>R.C.C. SURFACES. |
| 7. ALL CUTOUTS IN FLOOR, WALLS FOR CABLE ENTRIES ETC. TO<br>BE KEPT AS/REQUIREMENT OF RESPECTIVE DEPT'S.                                                                                                                                           |
| 8. 1000 WIDE PLINTH PROTECTION WITH BUILDING DRAIN SHALL BE<br>PROVIDED ALL AROUND THE BUILDING.                                                                                                                                                   |
| 9. ALL SUNSHADE, CANOPY & ROOF PROJECTIONS SHALL HAVE DRIP<br>WIDE GROOVES UNDERNEATH ALL TOWARDS THE PERIPHERIES.                                                                                                                                 |
| 10. SUITABLE SLOPE IN FLOOR SLAB FOR CABLE CELLAR AND A/C<br>PACKAGE ROOM SHALL BE PROVIDED ALONG FLOOR TRAYS<br>LOCATIONS SLOPE IN THE DRG. FOR DRAINAGE OF WATER.                                                                                |
| 11. SUBSTATION SWITCHGEAR SHALL BE AIR-CONDITIONED.                                                                                                                                                                                                |
| 12. SUBSTATION SWITCHGEAR SHALL HAVE CLEAR HEIGHT OF 4.5M.                                                                                                                                                                                         |
| 13. ALL DOORS REQUIRED IN AC AREAS SHALL BE AIR - TIGHT.                                                                                                                                                                                           |
| 14. FOR INTERNAL AND EXTERIOR FINISHES, ENGINEERING DESIGN<br>BASIS SHALL BE REFERRED.                                                                                                                                                             |
| 15. PROVISION FOR SEPARATE MALE & FEMALE TOILET IS REQUIRED DURING<br>DETAILED ENGINEERING.                                                                                                                                                        |
| 16. THE SIZE OF BUILDING AND ROOMS SHOWN ARE THE MINIMUM<br>AND INDICATIVE. THEY SHALL BE FINALIZED AND INCREASED AS<br>PER REQUIREMENT DURING DETAILED ENGINEERING.                                                                               |

## SCHEDULE OF DOORS & WINDOWS

| TYPE | OPENING SIZE | FRAME SIZE | LINTEL LEVEL |                                                                                                                    | NOS. |
|------|--------------|------------|--------------|--------------------------------------------------------------------------------------------------------------------|------|
| RS1  | 3000x3500    | -          | 3500         | STD. STEEL ROLLING SHUTTER, ELECTRICALLY OPERATED                                                                  |      |
| RS2  | 3000x3500    | -          | 3000         | STD. STEEL ROLLING SHUTTER, PARTLY GRILL TYPE, ELECTRICALLY OPERATED                                               |      |
| R1   | 1000x2100    | 0980x2900  | 2100         | 35 THK FULL PANNELLED DOOR SINGLE SHUTTER AS/EL STD. NO. 7.75-0004                                                 |      |
| FD1  | 2000x2700    | 1980x2690  | 2700         | 2 HR FIRE RATED, GLAZED DOOR AS PER MANUFACTURER'S SPECIFICATION.                                                  | F    |
| FD2  | 1500x2500    | 1480x2490  | 2500         | 2 HR FIRE RATED, GLAZED DOOR AS PER MANUFACTURER'S SPECIFICATION.                                                  |      |
| FD3  | 1200x2100    | 1180x2090  | 2100         | 2 HR FIRE RATED, GLAZED DOOR AS PER MANUFACTURER'S SPECIFICATION.                                                  |      |
| AL1  | 1500x2500    | 1480x2490  | 2500         | POWDER COATED ALUM. GLAZED DOOR WITH 6mm THK TOUGHENED GLASS, DOUBLE LEAF AS/EL STD. NO. 7.75-0014.                |      |
| AL2  | 1200x2100    | 1180x2090  | 2100         | SAME AS AL1 BUT SINGLE LEAF WITH AIR TIGHT                                                                         |      |
| AD1  | 1500x2500    | 1480x2490  | 2500         | PRESSED STEEL DOOR WITH PRESSED STEEL FRAME, DOUBLE SHUTTER AS/EL STD. NO. 7.75-0071                               |      |
| SD1A | 1500x2500    | 1480x2490  | 2500         | SAME AS SD1 BUT AIR TIGHT                                                                                          |      |
| SD2  | 1000x2100    | 980x2090   | 2100         | PRESSED STEEL DOOR WITH PRESSED STEEL FRAME, SINGLE SHUTTER AS/EL STD. NO. 7.75-0070                               |      |
| SD1  | 1200x2100    | 1180x2090  | 2100         | SAME AS SD2 BUT WITH LOCKERS AT BOTTOM.                                                                            |      |
| W1   | 2000x1800    | 1980x1790  | 2700         | ALUM. GLAZED WINDOW POWDER COATED WITH 6 mm THK TOUGHENED GLASS, PARTLY FIXED/ OPENABLE TYPE                       |      |
| V1   | 2000x 600    | 1980 590   | BEAM BOTTOM  | ALUM. GLAZED VENTILATOR POWDER COATED WITH 6 mm THK TOUGHENED GLASS, PARTLY OPENABLE & BENT FIX TYPE.              |      |
| V1A  | 2000x 600    | 1980 590   | BEAM BOTTOM  | ALUM. GLAZED VENTILATOR POWDER COATED WITH 6 mm THK TOUGHENED GLASS, FIX TYPE WITH AIR TIGHT.                      |      |
| V2   | 3000x 600    | 2980 590   | BEAM BOTTOM  | ALUM. GLAZED VENTILATOR POWDER COATED WITH 6 mm THK TOUGHENED GLASS, PARTLY FIXED/ OPENABLE TYPE WITH EXHAUST FAN. |      |
| V2A  | 3000x 600    | 2980 590   | 4550         | ALUM. GLAZED VENTILATOR POWDER COATED WITH 6 mm THK TOUGHENED GLASS, FIX TYPE WITH AIR TIGHT.                      |      |
| V3   | 2600x 600    | 2580 590   | BEAM BOTTOM  | SAME AS V2 WITH 2 EXHAUST FAN.                                                                                     |      |
| V4   | 1500x 600    | 1480 590   | 3000         | SAME AS V2.                                                                                                        |      |

**HOLD**

**LEGEND :-**  
F.R.L. - FINISH  
F.F.L. - FINISH

|    |    |                      |
|----|----|----------------------|
| FC | AC | FC = FALSE CEILING   |
| FF |    | AC = AIR CONDITIONED |
|    |    | FF = FALSE FLOORING  |

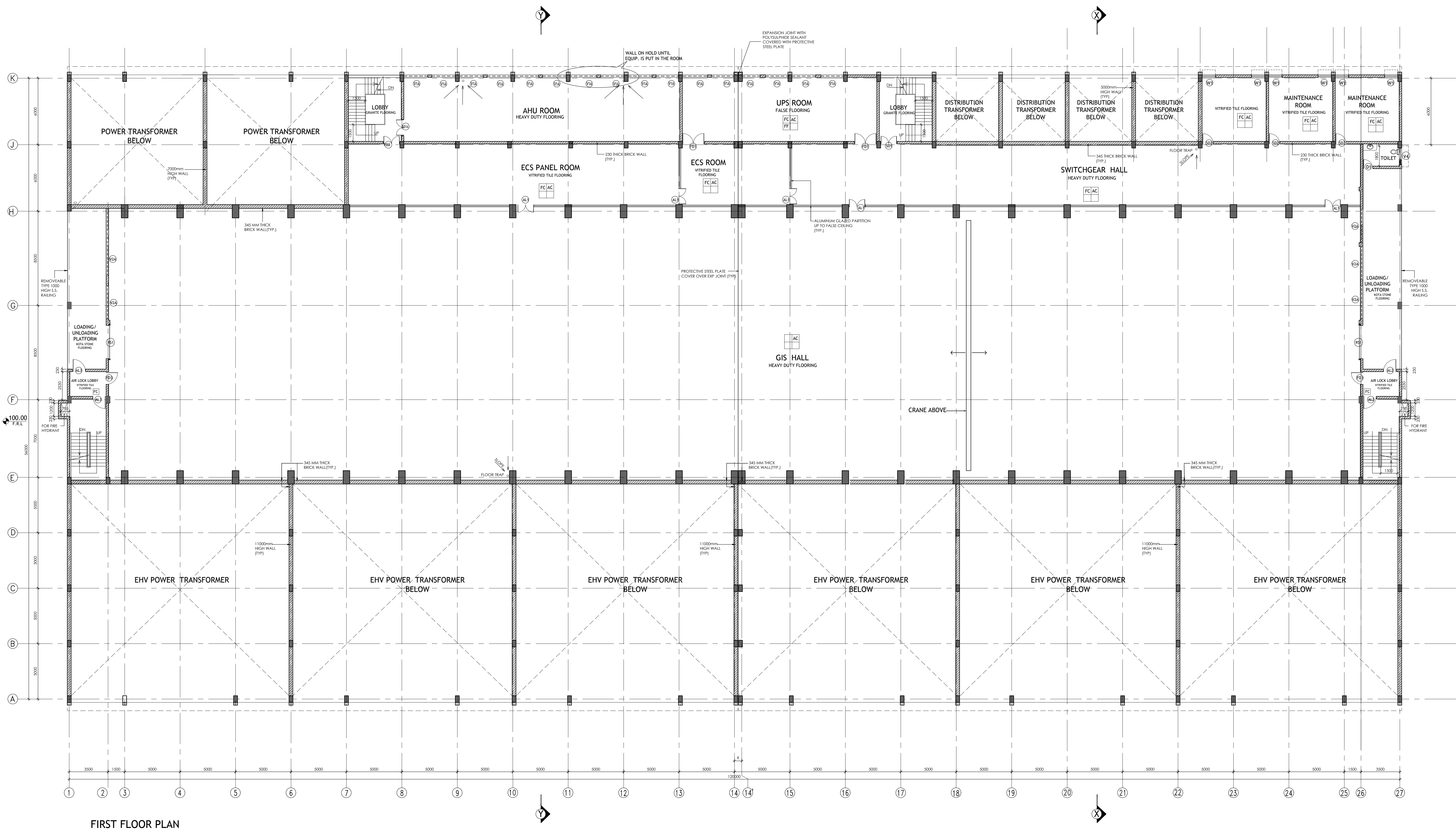
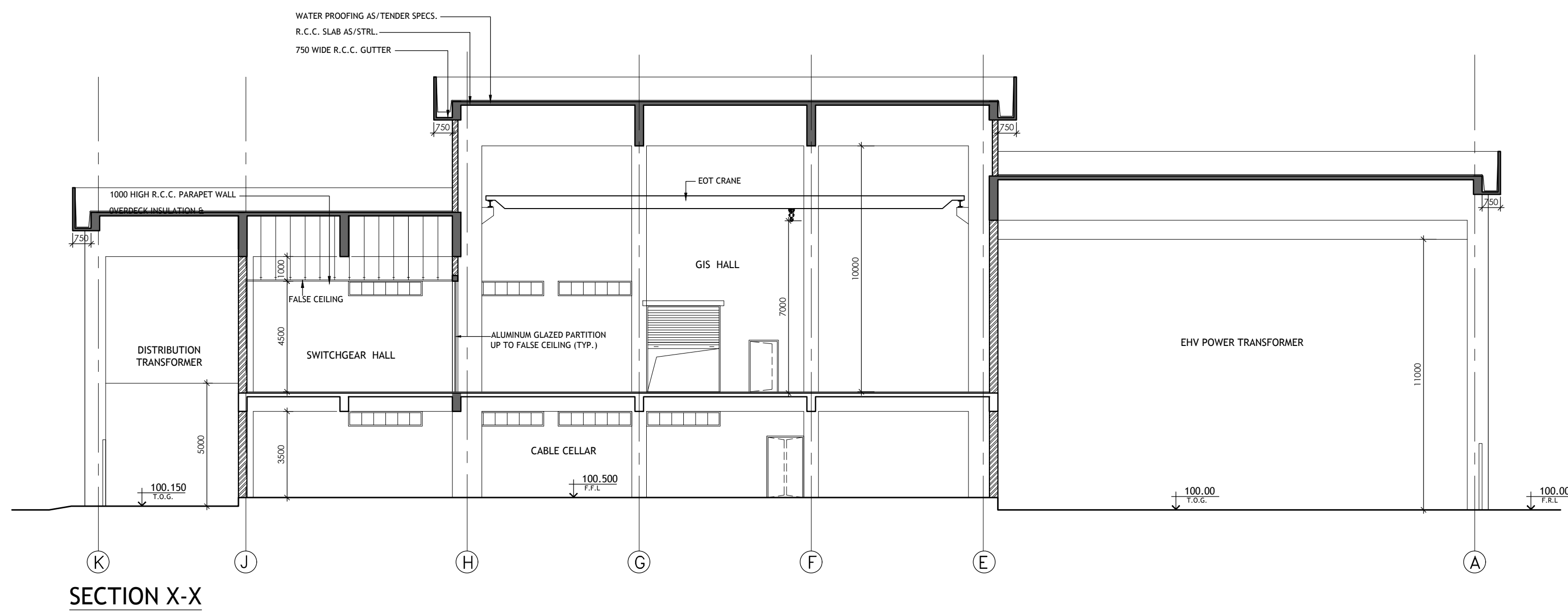
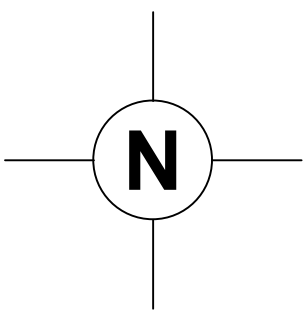
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|-----|----------|-----------------------------|----|------|------|-------|--|--|---|
| C   | 13.05.22 | REVISED @ISSUED WITH TENDER |    | SM   | GJK  | SD    |  |  |   |
| B   | 15.07.21 | REVISED @ISSUED WITH TENDER |    | SM   | GJK  | J5    |  |  |   |
| A   | 29.04.20 | ISSUED WITH TENDER          |    | SM   | GJK  | J5    |  |  |   |
| REV | DATE     | REVISIONS                   | BY | CHKD | APPD | PMP/C |  |  |   |



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B269-000-81-41-02407



| REF. DWG. NO.        | REFERENCE DRAWING TITLE                     |
|----------------------|---------------------------------------------|
| B269-000-81-41-02406 | SUBSTATION-100: GROUND FLOOR PLAN           |
| B269-000-81-41-02408 | SUBSTATION-100: SECOND FLOOR PLAN & SECTION |
|                      |                                             |
|                      |                                             |
|                      |                                             |

NOTES :-  
1. FOR ALL NOTES, REFER DWG. NO. B269-000-81-46-02406.

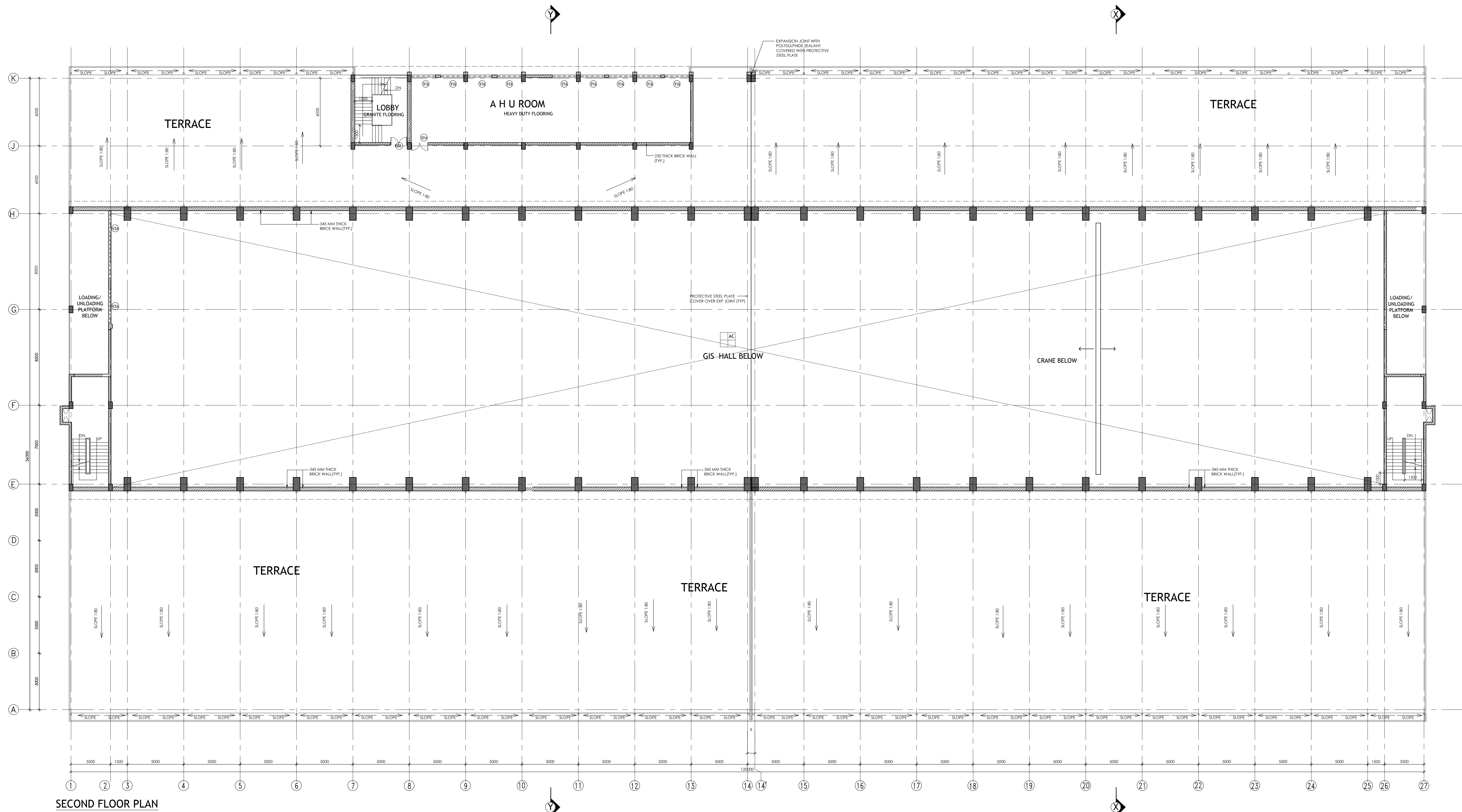
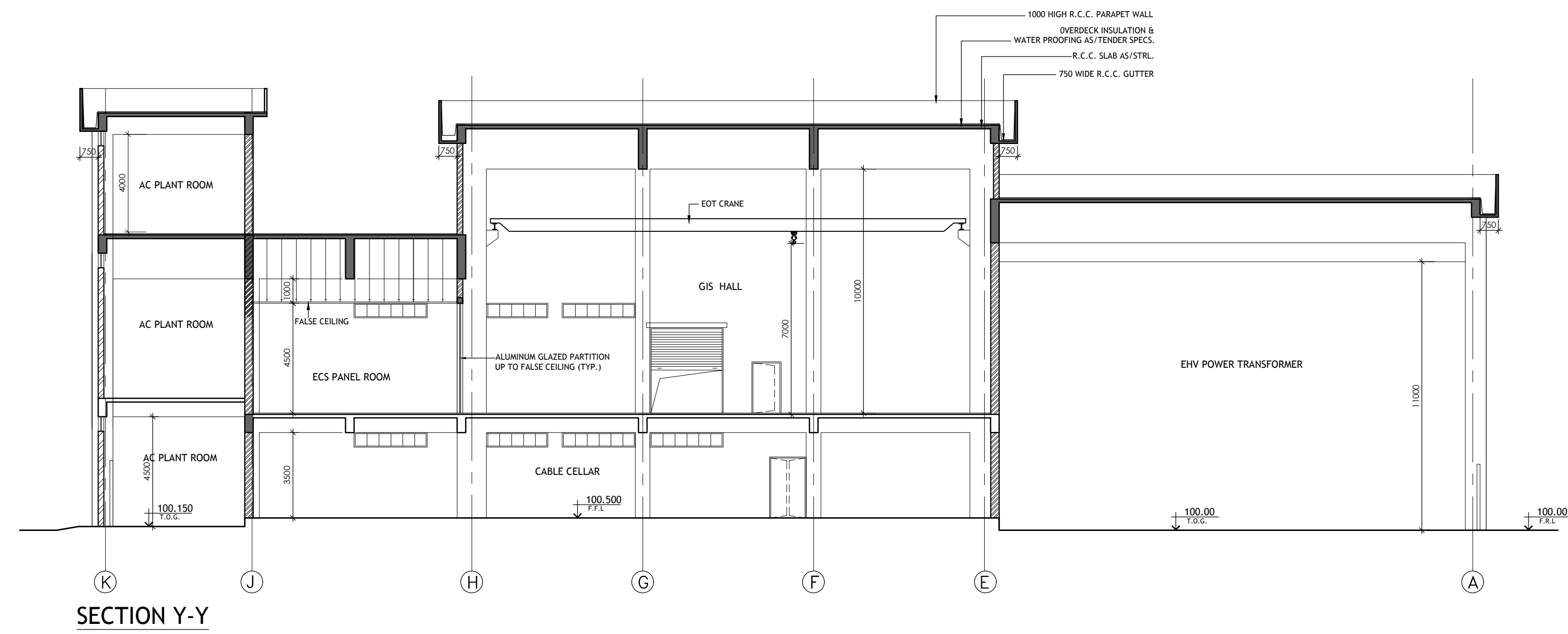
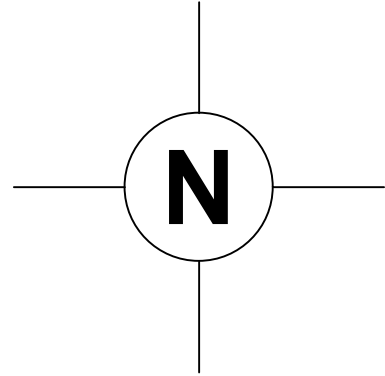
LEGEND :-  
F.R.L. - FINISHED ROAD LEVEL  
F.F.L. - FINISHED FLOOR LEVEL  
FC/AC - FALSE CEILING  
AC - AIR CONDITIONED  
FF - FALSE FLOORING

| REV. | DATE     | REVISIONS                  | BY | CHKD | APPD | PMPC |
|------|----------|----------------------------|----|------|------|------|
| C    | 13.05.22 | REVISED ISSUED WITH TENDER | SM | GJK  | SD   |      |
| B    | 15.07.21 | REVISED ISSUED WITH TENDER | SM | GJK  | JS   |      |
| A    | 29.04.20 | ISSUED WITH TENDER         | SM | GJK  | JS   |      |

|                                                              |                                               |
|--------------------------------------------------------------|-----------------------------------------------|
| ENGINEERS<br>INDIA LIMITED<br>(A Govt. of India Undertaking) |                                               |
| INDIAN OIL CORPORATION LTD.                                  |                                               |
| प्रीति प्रोजेक्ट<br>पानीपत रिफाईनरी                          | P25 PROJECT<br>PANIPAT REFINERY               |
| सब स्टेशन 100                                                | SUBSTATION-100<br>(MAIN RECEIVING SUBSTATION) |
| प्लान एवं काट                                                | FIRST FLOOR PLAN & SECTION                    |
| SCALE<br>1:100                                               | JOB NO.<br>B 2 6 9 0 0 0                      |
| UNIT<br>0 0 0                                                | DIVN. DEPT.<br>8 1 4 1 0 2 4 0 7              |
|                                                              | DWG. NO.<br>C                                 |
|                                                              | REV.<br>C                                     |



B269-000-81-41-02408



| REF. DWG. NO.        | REFERENCE DRAWING TITLE                    |
|----------------------|--------------------------------------------|
| B269-000-81-41-02406 | SUBSTATION-100- GROUND FLOOR PLAN          |
| B269-000-81-41-02407 | SUBSTATION-100- FIRST FLOOR PLAN & SECTION |
|                      |                                            |
|                      |                                            |
|                      |                                            |

NOTES :-

1. FOR ALL NOTES, REFER DWG. NO. B269-000-81-46-02406.

**LEGEND :-**  
 F.R.L. - FINISHED ROAD LEVEL  
 F.F.L. - FINISHED FLOOR LEVEL

|    |    |                      |
|----|----|----------------------|
| FC | AC | FC = FALSE CEILING   |
| FF |    | AC = AIR CONDITIONED |
|    |    | FF = FALSE FLOORING  |

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| <b>पी25 प्रोजेक्ट</b><br><b>पानीपत रिफाइनरी</b>                                                                                                                    | <b>SUBSTATION-100</b><br><b>(MAIN FLOORING PLAN &amp; SECTION)</b>                                                                                                        |
| <b>सम रोलेशन 100</b><br><b>प्लान व/अथ कट</b>                                                                                                                       | <b>SECOND FLOOR PLAN &amp; SECTION</b>                                                                                                                                    |
| <b>SCALE</b> <b>JOB NO.</b> <b>UNIT</b> <b>DIVN.</b> <b>DEPT.</b> <b>DWG NO.</b> <b>REV.</b>                                                                       | <b>1:100</b> <b>B 2 6 9</b> <b>0 0 0</b> <b>8 1</b> <b>411</b> <b>02</b> <b>4 0 8</b> <b>C</b>                                                                            |



यह दस्तावेज़ भारतीय विद्युत नियंत्रण बोर्ड (BIS) के तहत तैयार किया गया है। यह दस्तावेज़ केवल सूचना के लिए है और इसमें कोई भी गारंटी नहीं दी जाती है।  
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B269-999-16-50-00200

LOC : EXISTING REFINERY AREA

LOC : P25 NEW REFINERY AREA

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 SWITCHBOARDS. REQUIRED NUMBER OF OUTGOING FEEDERS INCLUDING SPARES AS PER FEEDER DATASHEETS, RESPECTIVE FEEDER HARDWARE DATASHEETS, ENGINEERING DESIGN BASIS & JOB SPECIFICATION ENCLOSED WITH THE 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

- EHV/HV CIRCUIT BREAKER
- AIR CIRCUIT BREAKER
- NEUTRAL GROUNDING RESISTOR
- TRANSFORMER
- GAS/AIR INSULATED BUSDUCT
- BUSBAR
- FUSE
- ON LOAD ISOLATOR/HERMAY DUTY SWITCH
- MINIATURE CIRCUIT BREAKER
- EARTH LEAKAGE CIRCUIT BREAKER
- INTERLOCK
- A/M AUTO/MANUAL
- PUSH BUTTON STATION WITH AMMETER
- PUSH BUTTON STATION
- POTENTIAL TRANSFORMER
- CAPACITOR BANK
- TRANSFORMER TRIP PB (BREAK GLASS TYPE)
- CURRENT TRANSFORMER
- CBCT
- EARTH LEAKAGE RELAY
- 3 POSITION MOTORISED ISOLATOR FOR GIS
- 2 POSITION MOTORISED ISOLATOR FOR GIS
- HIGH SPEED EARTH SWITCH
- MOTOR
- RECTIFIER/CHARGER
- INVERTER
- STATIC SWITCH
- BATTERIES
- CONTACTOR
- DRAWOUT FEATURE
- CABLE GLAND TERMINATION
- MOTOR PROTECTION RELAY
- SYNCHRONOUS TIMER

| REV. | DATE     | REVISIONS                             | BY | CHKD | APPD | PERMPC |
|------|----------|---------------------------------------|----|------|------|--------|
| E    | 18.05.22 | REVISED & ISSUED WITH TA-2            |    |      |      |        |
| D    | 11.04.22 | REVISED & ISSUED WITH TA-1            |    |      |      |        |
| C    | 29.09.21 | REVISED AND REISSUED WITH BID PACKAGE |    |      |      |        |
| B    | 05.07.21 | REVISED AND REISSUED WITH BID PACKAGE |    |      |      |        |
| A    | 12.05.20 | ISSUED WITH BID PACKAGE               |    |      |      |        |



INDIAN OIL CORPORATION LTD.

PANIPAT REFINERY EXPANSION PROJECT(P-25)

OVERALL SINGLE LINE DIAGRAM  
220KV GIS PACKAGE (MRSS-100)

| SCALE | JOB NO.       | UNIT | DIVN. | DEPT. | DWG. NO.    | REV. |
|-------|---------------|------|-------|-------|-------------|------|
| NTS   | B 2 6 9 9 9 9 | 1    | 6     | 5     | 0 0 0 2 0 0 | E    |



**TECHNICAL AMENDMENT NO: 01 (ELECTRICAL)**  
**TO**  
**TENDER: B269-999-16-50-EB-T-0020 FOR 220KV GIS PACKAGE**  
**(PROJECT: P-25, M/s IOCL-PANIPAT)**

|            |                                 |     |         |          |
|------------|---------------------------------|-----|---------|----------|
| 11.04.2022 | Issued as Technical Amendment-1 | MKM | RG      | HK       |
| DATE       | PURPOSE                         | BY  | CHECKED | APPROVED |

**SUBJECT** : **Technical Amendment No.: 01**  
**TENDER NO.** : **B269-999-16-50-EB-T-0020**

The terms, conditions and specifications of Bidding Document stand modified to the extent indicated under column "MODIFICATIONS/ADDITION/DELETION". Corresponding implications of the same, else-where in the bid package shall be taken care appropriately. All other terms & conditions, stipulations and specifications of Bidding Document shall remain unaltered.

| S.No | Section No./ Document No.    | Clause No./ Item No. | Subject                                       | Modifications / Additions/Deletions/ Clarification                                                                                                                                                                                                                                                                                                                                                                                         |
|------|------------------------------|----------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | B269-999-16-50-SP-0020 Rev.C | Complete Document    | Scope of Work & Job Specification             | <b>Modification:</b><br>Scope of work & Job Specification (Electrical) for 220kV GIS Package (B269-999-16-50-SP-0020 Rev.C) has been replaced by Scope of work & Job Specification (Electrical) for 220kV GIS Package (B269-999-16-50-SP-0020 Rev.D). Copy enclosed herewith.                                                                                                                                                              |
| 2.   | B269-999-16-50-DS-0031 Rev.C | Note-3               | 220kV Gas Insulated Switchgear Datasheet      | <b>Modification:</b><br>Mandatory spare list-Electrical (B269-999-16-50-SL-0020 Rev.C) has been replaced by next revision (B269-999-16-50-SL-0020 Rev.E). Copy enclosed herewith.<br><br>Equipments mentioned in note-3 in 220kV Gas Insulated Switchgear data sheet (B269-999-16-50-DS-0031 Rev. C) & 66kV Gas Insulated Switchgear data sheet (B269-999-16-50-DS-0032 Rev. B) shall be part of mandatory spares as specified in SL-0020. |
| 3.   | B269-999-16-50-DS-0034 Rev.C | Complete Document    | 220kV Feeder Details Datasheet                | <b>Modification:</b><br>220kV Feeder Detail data sheet (B269-999-16-50-DS-0034 Rev.C) has been replaced by B269-999-16-50-DS-0034 Rev.D. Copy enclosed herewith.                                                                                                                                                                                                                                                                           |
| 4.   | B269-999-16-50-DS-0035 Rev.C | Complete Document    | 66kV Feeder Details Datasheet                 | <b>Modification:</b><br>66kV Feeder Detail data sheet (B269-999-16-50-DS-0035 Rev.C) has been replaced by B269-999-16-50-DS-0035 Rev.D. Copy enclosed herewith.                                                                                                                                                                                                                                                                            |
| 5.   | B269-999-16-50-DS-0052 Rev.B | Complete Document    | Relay & SAS System Architecture for 220kV GIS | <b>Modification:</b><br>Data sheet (B269-999-16-50-DS-0052 Rev.B) has been replaced by B269-999-16-50-DS-0052 Rev.C. Copy enclosed herewith.                                                                                                                                                                                                                                                                                               |
| 6.   | B269-999-16-50-DS-0071 Rev.B | Complete Document    | Datasheet for 33kV Isolating Breaker Panel    | <b>Modification:</b><br>Data sheet (B269-999-16-50-DS-0071 Rev.B) has been replaced by B269-999-16-50-DS-0071 Rev.C. Copy enclosed herewith.                                                                                                                                                                                                                                                                                               |
| 7.   | B269-999-16-50-DS-0130 Rev.B | Complete Document    | System Architecture for IBPs & MV Switchboard | <b>Modification:</b><br>Data sheet (B269-999-16-50-DS-0130 Rev.B) has been replaced by B269-999-16-50-DS-0130 Rev.C. Copy enclosed herewith.                                                                                                                                                                                                                                                                                               |



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TO  
220KV GIS PACKAGE**

**DOCUMENT No.  
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|     |                               |                   |                                          |                                                                                                                                                                                                                                                                                                                            |
|-----|-------------------------------|-------------------|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8.  | B269-999-16-50-DS-0301 Rev.C  | Complete Document | Datasheet for 220/66kV power transformer | <b>Modification:</b><br>Following have been revised in data sheet (B269-999-16-50-DS-0301 Rev.C):<br>a. Sr. No. 16, No negative tolerance shall be considered for Impedance at max. MVA i.e. ONAF.<br>b. Sr. no. 25, Range of OLTC shall be considered as -17.5% to +12.5%.<br>Nos. of tap shall be considered as 24 nos.  |
| 9.  | B269-999-16-50-DS-0306 Rev.B  | Complete Document | Datasheet for 220/33kV power transformer | <b>Modification:</b><br>Following have been revised in data sheet (B269-999-16-50-DS-0306 Rev. B):<br>a. Sr. No. 16, No negative tolerance shall be considered for Impedance at max. MVA i.e. ONAF.<br>b. Sr. no. 25, Range of OLTC shall be considered as -17.5% to +12.5%.<br>Nos. of tap shall be considered as 24 nos. |
| 10. | B269-999-16-50-00200 Rev.C    | Complete Document | Key SLD                                  | <b>Modification:</b><br>Key SLD (B269-999-16-50-00200 Rev.C) is replaced by B269-999-16-50-00200 Rev.D. Copy enclosed herewith.                                                                                                                                                                                            |
| 11. | B269-999-16-50-OD-0020 Rev.C  | Complete Document | Approved Vendor List                     | <b>Modification:</b><br>Vendor list (B269-999-16-50-OD-0020 Rev. C) has been replaced by B269-999-16-50-OD-0020 Rev. D. Copy enclosed herewith.                                                                                                                                                                            |
| 12. | B269-999-16-50-EDB-1001 Rev.0 | 5.7.1 (Note-5)    | EHV GIBD                                 | <b>Modification:</b><br><b>The note 5 of cl. No. 5.7.1 (EHV GIBD) of EDB stands deleted and is replaced with the following:</b><br>66kV GIBD shall be 3 phase enclosure or single phase enclosure as per vendor standard design as per cl. No. 6.15.1 of EIL standard specification 6-51-0066.                             |

|     |                   |   |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|-------------------|---|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13. | Table of Contents | - | Data sheet (Electrical)    | <b>Addition:</b><br>Following datasheets have been added (copy enclosed): <ol style="list-style-type: none"> <li>66/6.9kV power transformer (B269-999-16-50-DS-0304 Rev.D)</li> <li>66kV Cable (B269-999-16-50-DS-0215 Rev.A)</li> <li>33kV &amp; 6.6kV Cable (B269-999-16-50-DS-0200 Rev.A)</li> <li>Neutral Grounding resistor (B269-999-16-50-DS-0351 Rev.A)</li> <li>6.6kV bus duct (B269-999-16-50-DS-0002 Rev.B)</li> <li>6.6kV Switchboard datasheet (B269-999-16-50-DS-0001 Rev.B)</li> <li>Feeder list for 6.6kV switchboard (B269-999-16-50-DS-0075 Rev.A)</li> <li>6.6kV capacitor bank (B269-999-16-50-DS-0150 Rev.A)</li> <li>ECS I/O list for 6.6kV Switchboard (B269-999-16-50-DS-0686 Rev.A)</li> <li>SAS for New Gantry system ((B269-999-16-50-DS-0131 Rev.A)</li> <li>Experience Record performa for 66kV GIS (B269-999-16-50-ERP-0020 Rev. 0)</li> <li>Experience Record performa for 66kV GIBD (B269-999-16-50-ERP-0021 Rev. 0)</li> <li>Hardware datasheet for various feeders of 6.6kV switchboard:               <ul style="list-style-type: none"> <li>B269-999-16-50-DS-0003 Rev.B (Incomer from transformer)</li> <li>B269-999-16-50-DS-0005 Rev.B (Bus coupler with FBT)</li> <li>B269-999-16-50-DS-0006 Rev.B (Outgoing transformer feeder)</li> <li>B269-999-16-50-DS-0008 Rev.B (Capacitor feeder)</li> <li>B269-999-16-50-DS-0010 Rev.B (Control supply)</li> <li>B269-999-16-50-DS-0011 Rev.A (Bus PT)</li> <li>B269-999-16-50-DS-0016 Rev.B (Bus coupler with manual change over)</li> <li>B269-999-16-50-DS-0028 Rev.A (Outgoing plant feeder)</li> </ul> </li> </ol> |
| 14. | Table of Contents | - | EIL Standard specification | <b>Addition:</b><br>Following EIL standard specification have been added (copy enclosed): <ol style="list-style-type: none"> <li>6-51-0020 Rev.6 (HV Capacitor Bank)</li> <li>6-51-0043 Rev.8 (Neutral Grounding Resistor)</li> <li>6-51-0065 Rev-01 Specification for high voltage gas insulated switchgear</li> <li>6-51-0067 Rev.1 (Extra High Voltage Cable &amp; Accessories)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 15. | Table of Contents | - | EIL Inspection & Test Plan | <b>Addition:</b><br>Following Inspection & Test Plan have been added: <ol style="list-style-type: none"> <li>6-81-1020 Rev.5 (HV Capacitor bank)</li> <li>6-81-1043 Rev.4 (Neutral grounding resistor)</li> <li>6-81-1067 Rev.0 (Extra high voltage cables and accessories)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

TECHNICAL AMENDMENT NO.01  
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220KV GIS PACKAGE

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|     |                   |   |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|-------------------|---|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16. | Annexure-A        | - | Existing System Details                                   | <p>Details pertaining to existing 220kV BHEL substation (S/S-64) has been added under Annexure-A for reference including following details.</p> <ul style="list-style-type: none"> <li>a. 220kV BHEL Substation details (SS-64)</li> <li>b. Busbar differential protection</li> <li>c. PD monitoring system</li> <li>d. Substation automation system</li> <li>e. Fire alarm system</li> <li>f. PLCC panel</li> <li>g. Location of (95x95) mtr. area &amp; existing 220kV BHEL substation (SS-64)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 17. | TABLE OF CONTENTS | - | Electrical Attachments<br>(latest standard specification) | <p><b>Modification:</b></p> <ul style="list-style-type: none"> <li>(i) 6-51-0004 Rev. 5 is replaced with 6-51-0004 Rev. 6 *</li> <li>(ii) 6-51-0018 Rev. 5 is replaced with 6-51-0018 Rev. 6 *</li> <li>(iii) 6-51-0019 Rev. 5 is replaced with 6-51-0019 Rev. 6 *</li> <li>(iv) 6-51-0047 Rev. 3 is replaced with 6-51-0047 Rev. 4 *</li> </ul> <p>*Copy of latest standard specification is attached herewith.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 18. | TABLE OF CONTENTS | - | Electrical Attachments<br>(latest standard)               | <p><b>Modification:</b></p> <ul style="list-style-type: none"> <li>(i) 7-51-0002 Rev. 5 is replaced with 7-51-0002 Rev. 6 *</li> <li>(ii) 7-51-0011 Rev. 5 is replaced with 7-51-0011 Rev. 6 *</li> <li>(iii) 7-51-0021 Rev. 5 is replaced with 7-51-0021 Rev. 6 *</li> <li>(iv) 7-51-0103 Rev. 6 is replaced with 7-51-0103 Rev. 7 *</li> <li>(v) 7-51-0104 Rev. 5 is replaced with 7-51-0104 Rev. 6 *</li> <li>(vi) 7-51-0105 Rev. 6 is replaced with 7-51-0105 Rev. 7 *</li> <li>(vii) 7-51-0106 Rev. 5 is replaced with 7-51-0106 Rev. 6 *</li> <li>(viii) 7-51-0107 Rev. 5 is replaced with 7-51-0107 Rev. 6 *</li> <li>(ix) 7-51-0108 Rev. 6 is replaced with 7-51-0108 Rev. 7 *</li> <li>(x) 7-51-0109 Rev. 5 is replaced with 7-51-0109 Rev. 6 *</li> <li>(xi) 7-51-0111 Rev. 5 is replaced with 7-51-0111 Rev. 6 *</li> <li>(xii) 7-51-0115 Rev. 5 is replaced with 7-51-0115 Rev. 6 *</li> <li>(xiii) 7-51-0116 Rev. 7 is replaced with 7-51-0116 Rev. 8 *</li> <li>(xiv) 7-51-0214 Rev. 5 is replaced with 7-51-0214 Rev. 6 *</li> <li>(xv) 7-51-0215 Rev. 5 is replaced with 7-51-0215 Rev. 6 *</li> <li>(xvi) 7-51-0325 Rev. 4 is replaced with 7-51-0325 Rev. 5 *</li> <li>(xvii) 7-51-0332 Rev. 3 is replaced with 7-51-0332 Rev. 4 *</li> <li>(xviii) 7-51-0335 Rev. 3 is replaced with 7-51-0335 Rev. 4 *</li> <li>(xix) 7-51-0336 Rev. 3 is replaced with 7-51-0336 Rev. 4 *</li> </ul> <p>*Copy of latest standard is attached herewith.</p> |

(SIGNATURE AND STAMP OF BIDDER)

|                     |                                                                                         |                                    |                        |                          |                                      |              |
|---------------------|-----------------------------------------------------------------------------------------|------------------------------------|------------------------|--------------------------|--------------------------------------|--------------|
| Project             | Overall Project Management and EPCM Services for Capacity Expansion of Panipat Refinery |                                    |                        | Client                   | IOCL REFINERY DIVISION - HEAD OFFICE |              |
| Unit                | COMMON                                                                                  |                                    | Location               | Job No.                  | B269                                 | Unit No. 999 |
| PURCHASER'S DATA    |                                                                                         |                                    |                        |                          |                                      |              |
| A.                  | Site Conditions                                                                         |                                    |                        |                          |                                      |              |
| 1.                  | Maximum Ambient Temperature                                                             | °C                                 | 50                     |                          |                                      |              |
| 2.                  | Minimum Ambient Temperature                                                             | °C                                 | 5                      |                          |                                      |              |
| 3.                  | Design Ambient Temperature                                                              | °C                                 | 45                     |                          |                                      |              |
| 4.                  | Relative Humidity                                                                       | %                                  | 90                     |                          |                                      |              |
| 5.                  | Altitude Above MSL                                                                      | mm                                 | 1000                   |                          |                                      |              |
| 6.                  | Environment                                                                             | Hot, Humid & Corrosive             |                        |                          |                                      |              |
| B.                  | Operating Conditions                                                                    |                                    |                        |                          |                                      |              |
| 1.                  | Voltage                                                                                 | kV                                 | 6.6 +/- 10 %           |                          |                                      |              |
| 2.                  | Frequency                                                                               | Hz                                 | 50 +/- 3 %             |                          |                                      |              |
| 3.                  | No of phases                                                                            | Three                              |                        |                          |                                      |              |
| 4.                  | System fault level                                                                      | kA                                 | 40                     |                          |                                      |              |
| 5.                  | System earthing                                                                         | Resistance Earthing                |                        |                          |                                      |              |
| 6.                  | Auxiliary supply                                                                        |                                    |                        |                          |                                      |              |
|                     | AC                                                                                      | V                                  | 240 +/- 5 %            |                          |                                      |              |
|                     | DC                                                                                      | V                                  | 110 +15% /- 10 %       |                          |                                      |              |
| C.                  | Electrical Data                                                                         |                                    |                        |                          |                                      |              |
| 1.                  | Busbar current rating (inside panel at design temp.)                                    |                                    |                        | As per Job Specification |                                      |              |
| 2.                  | 1 sec. Short Circuit withstand capacity                                                 | kA                                 | 40                     |                          |                                      |              |
| 3.                  | System Breaking capacity                                                                | kA                                 | 40                     |                          |                                      |              |
|                     | % D.C. Component                                                                        |                                    |                        | As per IEC               |                                      |              |
| 4.                  | System making capacity                                                                  | kA(peak)                           | 100                    |                          |                                      |              |
| 5.                  | Type of Circuit Breaker                                                                 | VCB                                |                        |                          |                                      |              |
|                     | Shunt Trip Coil-1 :                                                                     | V                                  | 110 DC                 |                          |                                      |              |
|                     | Shunt Trip Coil-2 :                                                                     | V                                  | 230V AC (Refer Note-2) |                          |                                      |              |
| 6.                  | Duty Cycle of C.B.                                                                      | O-3min-CO-3min-CO                  |                        |                          |                                      |              |
| 7.                  | Suitability for Cap. Switching                                                          | Required                           |                        |                          |                                      |              |
| 8.                  | Surge supressor for all Feeders                                                         | Yes                                |                        |                          |                                      |              |
| 9.                  | Provision of earthing                                                                   |                                    |                        |                          |                                      |              |
|                     | Earthing truck                                                                          | Required                           |                        |                          |                                      |              |
|                     | Earthing switch                                                                         | Not Required                       |                        |                          |                                      |              |
| D.                  | Miscellaneous                                                                           |                                    |                        |                          |                                      |              |
| 1.                  | Interface with ECS                                                                      | Required                           |                        |                          |                                      |              |
| 2.                  | Incoming Power Entry                                                                    | Cable/Bus Duct                     |                        |                          |                                      |              |
| 3.                  | Cable Entry                                                                             | Bottom                             |                        |                          |                                      |              |
| 4.                  | Separate bolted removable gland palte for cable entry                                   | Reqd.(Gland Plate Drilled at side) |                        |                          |                                      |              |
| 5.                  | Cable glands and lugs for cable termination                                             | Refer Job Specification            |                        |                          |                                      |              |
| 6.                  | Paint shade                                                                             | RAL-7032                           |                        |                          |                                      |              |
| 7.                  | Windows at the rear side of panels for thermography                                     | Not Required                       |                        |                          |                                      |              |
| MANUFACTURER'S DATA |                                                                                         |                                    |                        |                          |                                      |              |
| A.                  | Switchboards                                                                            |                                    |                        |                          |                                      |              |
| 1.                  | Make                                                                                    |                                    |                        |                          |                                      |              |
|                     |                                                                                         |                                    |                        |                          |                                      |              |
|                     |                                                                                         |                                    |                        |                          |                                      |              |
|                     |                                                                                         |                                    |                        |                          |                                      |              |
| B                   | 13-SEP-2021                                                                             | ISSUED WITH MR/TENDER              | V V S N MURTY          | ANIL KUMAR GARHWAL       | HARISH KUMAR                         |              |
| A                   | 27-APR-2020                                                                             | ISSUED WITH MR/TENDER              | JAYENDRA L CHAUHAN     | 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> |  | <b>Job No.</b>  | B269                                 |
|                |                                                                                         |                 |  | <b>Unit No.</b> | 999                                  |

|     |                                                                                                                                                    |    |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 2.  | Type designation                                                                                                                                   |    |
| 3.  | Degree of protection                                                                                                                               |    |
| 4.  | Max. overall weight of C.B. panel                                                                                                                  | Kg |
| 5.  | Overall dimensions of C.B. panel                                                                                                                   |    |
|     | Width                                                                                                                                              | mm |
|     | Depth                                                                                                                                              | mm |
|     | Height                                                                                                                                             | mm |
| 6.  | Overall dimensions of dummy / gland plate for cable entry                                                                                          |    |
|     | Width                                                                                                                                              | mm |
|     | Depth                                                                                                                                              | mm |
|     | Height                                                                                                                                             | mm |
| 7.  | Overall weight and dimensions of largest shipping section                                                                                          |    |
|     | Weight                                                                                                                                             | Kg |
|     | Width                                                                                                                                              | mm |
|     | Depth                                                                                                                                              | mm |
|     | Height                                                                                                                                             | mm |
| 8.  | Overall dimensions of each swbd. including all dummy/adaptor/rear extension panels                                                                 |    |
|     | Width                                                                                                                                              | mm |
|     | Depth                                                                                                                                              | mm |
|     | Height                                                                                                                                             | mm |
| 9.  | Recommended clearances                                                                                                                             |    |
|     | Front                                                                                                                                              | mm |
|     | Rear                                                                                                                                               | mm |
|     | Above                                                                                                                                              | mm |
| 10. | Shock loading on foundation                                                                                                                        |    |
| 11. | Max. size/no. of cables that can be terminated inside the panel                                                                                    |    |
|     | without rear extension panel                                                                                                                       |    |
|     | with rear extension panel                                                                                                                          |    |
|     | size of rear extension panel                                                                                                                       |    |
| 12. | Clearance in air                                                                                                                                   |    |
|     | Phase to Phase (min.)                                                                                                                              | mm |
|     | Phase to Earth (min.)                                                                                                                              | mm |
| 13. | Busbar current rating at design ambient temperature                                                                                                | A  |
| 14. | Busbar (separately for each swbd)                                                                                                                  |    |
|     | (a).Horizontal main busbar size (No. of flats x size of each flat)                                                                                 |    |
|     | (b).Horizontal main busbar size as tested at CPRI for full short ckt withstand as per specification requirement (No. of flats x size of each flat) |    |
|     | (c).Vertical dropper size (No. of flats x size of each flat)                                                                                       |    |
| 15. | Horizontal main busbar/Vertical busbar material                                                                                                    |    |
| 16. | Insulating material (Busbar supports)                                                                                                              |    |
| 17. | Earth busbar size                                                                                                                                  |    |
| 18. | Earth busbar material                                                                                                                              |    |
| 19. | 1 min. power frequency withstand voltage (rms)                                                                                                     | kV |
|     | Over voltage factor for PTs                                                                                                                        |    |
| 20. | Impulse withstand voltage (peak)                                                                                                                   | kV |

|          |             |                       |                    |                    |              |
|----------|-------------|-----------------------|--------------------|--------------------|--------------|
|          |             |                       |                    |                    |              |
|          |             |                       |                    |                    |              |
| B        | 13-SEP-2021 | ISSUED WITH MR/TENDER | V V S N MURTY      | ANIL KUMAR GARHWAL | HARISH KUMAR |
| A        | 27-APR-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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>       |                    | <b>Job No.</b>     | B269                                 | <b>Unit No.</b> 999 |
|                | Wave shape of impulse voltage                                                                                    |                       |                    |                    |                                      |                     |
| 21.            | 1 sec. short ckt. Withstand capacity                                                                             |                       | kA                 |                    |                                      |                     |
| 22.            | Peak dynamic withstand capacity                                                                                  |                       | kA                 |                    |                                      |                     |
| 23.            | Safety Features                                                                                                  |                       |                    |                    |                                      |                     |
|                | (a).Heat shrinkable sleeves, rated to withstand the system line to line voltage for one min., provided on busbar |                       |                    |                    |                                      |                     |
|                | (b).Removable FRP shrouds for all busbar joints and tap-off connections provided                                 |                       |                    |                    |                                      |                     |
|                | (c).Arc propagation barrier in busbar compartment provided                                                       |                       |                    |                    |                                      |                     |
|                | (d).Breaker service, test and drawn-out position provided                                                        |                       |                    |                    |                                      |                     |
|                | (e).Distinct overall lockable door for breaker compartment provided                                              |                       |                    |                    |                                      |                     |
|                | (f).Automatic safety shutter provided                                                                            |                       |                    |                    |                                      |                     |
|                | (g).Independent pressure release flaps provided for all HV compartments                                          |                       |                    |                    |                                      |                     |
|                | (h).Wire mesh for all louvered openings provided                                                                 |                       |                    |                    |                                      |                     |
|                | (i).Suitable interlocks to prevent faulty operation as per Cl. 4.4.10 of spec. 6-51-0001 provided                |                       |                    |                    |                                      |                     |
|                | <b>B. Circuit Breaker</b>                                                                                        |                       |                    |                    |                                      |                     |
| 1.             | Type                                                                                                             |                       |                    |                    |                                      |                     |
|                | 2nd shunt trip coil for VFD feeders                                                                              |                       |                    |                    |                                      |                     |
| 2.             | Make                                                                                                             |                       |                    |                    |                                      |                     |
| 3.             | Type Designation                                                                                                 |                       |                    |                    |                                      |                     |
| 4.             | Circuit Breaker mounting in panel                                                                                |                       |                    |                    |                                      |                     |
| 5.             | No. of poles/phase                                                                                               |                       |                    |                    |                                      |                     |
| 6.             | Current rating (in free air)                                                                                     |                       | A                  |                    |                                      |                     |
| 7.             | Current rating inside the panel at specified design temperature                                                  |                       | A                  |                    |                                      |                     |
| 8.             | Short time rating ( 1sec.)                                                                                       |                       | kA                 |                    |                                      |                     |
| 9.             | Symmetrical breaking capacity                                                                                    |                       | kA                 |                    |                                      |                     |
| 9.1            | % D.C. Component                                                                                                 |                       |                    |                    |                                      |                     |
| 10.            | Peak making current                                                                                              |                       | kA                 |                    |                                      |                     |
| 11.            | 1 min. dry withstand voltage (power frequency)                                                                   |                       | kV                 |                    |                                      |                     |
| 12.            | Duty Cycle                                                                                                       |                       |                    |                    |                                      |                     |
| 13.            | Total opening time                                                                                               |                       | m sec.             |                    |                                      |                     |
| 14.            | Total closing time                                                                                               |                       | m sec.             |                    |                                      |                     |
| 15.            | Power required for opening                                                                                       |                       | W/VA               |                    |                                      |                     |
| 16.            | Power required for closing                                                                                       |                       | W/VA               |                    |                                      |                     |
| 17.            | Power required for spring charging motor                                                                         |                       | W/VA               |                    |                                      |                     |
| 18.            | Breaker is trip free                                                                                             |                       |                    |                    |                                      |                     |
| 19.            | Closing mechanism                                                                                                |                       |                    |                    |                                      |                     |
| 20.            | Provision of manual spring charging provided                                                                     |                       |                    |                    |                                      |                     |
| 21.            | Mechanical Trip PB provided                                                                                      |                       |                    |                    |                                      |                     |
|                |                                                                                                                  |                       |                    |                    |                                      |                     |
|                |                                                                                                                  |                       |                    |                    |                                      |                     |
|                |                                                                                                                  |                       |                    |                    |                                      |                     |
| B              | 13-SEP-2021                                                                                                      | ISSUED WITH MR/TENDER | V V S N MURTY      | ANIL KUMAR GARHWAL | HARISH KUMAR                         |                     |
| A              | 27-APR-2020                                                                                                      | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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> |  | <b>Job No.</b>  | B269                                 |
|                |                                                                                         |                 |  | <b>Unit No.</b> | 999                                  |
| 22.            | Mech. On/Off indicator provided                                                         |                 |  |                 |                                      |
| 23.            | Operation counter provided                                                              |                 |  |                 |                                      |
| 24.            | Time taken for spring charging                                                          | sec.            |  |                 |                                      |
| 25.            | No. of aux. contacts and their current ratings                                          |                 |  |                 |                                      |
| 26.            | Interrupter                                                                             |                 |  |                 |                                      |
|                | (a).Make                                                                                |                 |  |                 |                                      |
|                | (b).Pressure switch for monitoring of SF6 gas pressure provided                         |                 |  |                 |                                      |
|                | (c).Re-filling arrangement of SF6                                                       |                 |  |                 |                                      |
| 27.            | LOTO (Lock-Out Tag-Out) Provision for mechanical locking arrangement                    |                 |  |                 |                                      |
| 28.            | Suppressor                                                                              |                 |  |                 |                                      |
|                | Type designation                                                                        |                 |  |                 |                                      |
|                | Make                                                                                    |                 |  |                 |                                      |
| 27.            | Derating reqd. for Cap. Switching                                                       |                 |  |                 |                                      |
| 29.            | Earthing System                                                                         |                 |  |                 |                                      |
| 30.            | Copies of following test certificates enclosed                                          |                 |  |                 |                                      |
|                | For each type of offered circuit breaker panel with breake                              |                 |  |                 |                                      |
|                | (a).Short Circuit tests (Peak and 1 sec.withstand)                                      |                 |  |                 |                                      |
|                | (b).Heat run test                                                                       |                 |  |                 |                                      |
|                | (c).Internal arc test                                                                   |                 |  |                 |                                      |
|                | (d).Impulse and power freq. withstand                                                   |                 |  |                 |                                      |
|                | For each type of offered circuit breaker (in panel)                                     |                 |  |                 |                                      |
|                | (a).Short Circuit test duties                                                           |                 |  |                 |                                      |

#### Eil Notes

- 1 Vendor shall furnish the dimensions of various types/ratings of swbds., CB panels and dummy/adaptor panels separately.
- 2 For all HV Circuit Breakers feeding HV VFDs, two nos. trip coil shall be provided. 1no. trip coil shall operate on 110V DC supply and other trip coil shall operate on 230V AC UPS supply.
- 3 All offered switchboards shall have IAC rating of AFLR 40 kA for 0.2 Sec.
- 4 Variation/ Clarification against the standard specification for HV switchboards 6-51-0001, shall be as per the MoU agreed with EIL by respective HV switchboard manufacturer. No further deviations to tender requirements shall be entertained.

|          |             |                       |                    |                    |              |
|----------|-------------|-----------------------|--------------------|--------------------|--------------|
|          |             |                       |                    |                    |              |
| B        | 13-SEP-2021 | ISSUED WITH MR/TENDER | V V S N MURTY      | ANIL KUMAR GARHWAL | HARISH KUMAR |
| A        | 27-APR-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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              |                    | Job No.                           | B269                                 | Unit No. 999 |
| PURCHASER'S DATA    |                                                                                              |                       |                    |                                   |                                      |              |
| A.                  | Site Conditions                                                                              |                       |                    |                                   |                                      |              |
| 1.                  | Maximum Ambient Temperature                                                                  |                       |                    | °C                                | 50                                   |              |
| 2.                  | Minimum Ambient Temperature                                                                  |                       |                    | °C                                | 5                                    |              |
| 3.                  | Design Ambient Temperature                                                                   |                       |                    | °C                                | 45                                   |              |
| 4.                  | Relative Humidity                                                                            |                       |                    | %                                 | 90                                   |              |
| 5.                  | Altitude Above MSL                                                                           |                       |                    | m                                 | 1000                                 |              |
| 6.                  | Environment                                                                                  |                       |                    | Hot, Humid & Corrosive            |                                      |              |
| B.                  | Operating Condition                                                                          |                       |                    |                                   |                                      |              |
| 1.                  | Voltage                                                                                      |                       |                    | 6.6 kV ± 10 % TP                  |                                      |              |
| 2.                  | Frequency                                                                                    |                       |                    | 50 Hz ± 3 %                       |                                      |              |
| 3.                  | No. of Phases                                                                                |                       |                    | Three                             |                                      |              |
| 4.                  | System Fault level                                                                           |                       |                    | kA                                | 40                                   |              |
| 5.                  | System earthing                                                                              |                       |                    | Resistance earthed                |                                      |              |
| 6.                  | Auxillary supply AC                                                                          |                       |                    | 240 V ± 10 %                      |                                      |              |
| C.                  | Busduct Details                                                                              |                       |                    |                                   |                                      |              |
| 1.                  | Rated Voltage                                                                                |                       |                    | 6.6 kV ± 10 %                     |                                      |              |
| 2.                  | Current Rating                                                                               |                       |                    | A                                 | Refer Job Specification              |              |
| 3.                  | Short circuit rating                                                                         |                       |                    | kA                                | Refer Job Specification              |              |
| 4.                  | Type                                                                                         |                       |                    | TP Phase segregated               |                                      |              |
| 5.                  | Location                                                                                     |                       |                    | Outdoor/Indoor                    |                                      |              |
| 6.                  | Wall frame assembly with seal off bushings and bus conductors                                |                       |                    | Required                          |                                      |              |
| 7.                  | Paint shade of enclosure                                                                     |                       |                    | RAL 7031 Outdoor, RAL 7032 Indoor |                                      |              |
| 8.                  | Space heater and breather with silica gel in bus duct                                        |                       |                    | Required                          |                                      |              |
| 9.                  | Supporting arrangement of busduct                                                            |                       |                    | Required                          |                                      |              |
| MANUFACTURER'S DATA |                                                                                              |                       |                    |                                   |                                      |              |
| 1.                  | Make                                                                                         |                       |                    |                                   |                                      |              |
| 2.                  | Current rating                                                                               |                       |                    |                                   |                                      |              |
| 3.                  | Short circuit rating                                                                         |                       |                    |                                   |                                      |              |
| 4.                  | Type                                                                                         |                       |                    |                                   |                                      |              |
| 5.                  | Degree of protection                                                                         |                       |                    |                                   |                                      |              |
| 6.                  | canopy of outdoor busduct                                                                    |                       |                    |                                   |                                      |              |
| 7.                  | Busbar details                                                                               |                       |                    |                                   |                                      |              |
| a.                  | Busbar Material                                                                              |                       |                    |                                   |                                      |              |
| b.                  | Busbar size (No. of flats x size of each flat)                                               |                       |                    | mm <sup>2</sup>                   |                                      |              |
| c.                  | Busbar size as tested at CPRI for full short ckt withstand(No. of flats x size of each flat) |                       |                    | mm <sup>2</sup>                   |                                      |              |
| d.                  | Busbar insulator                                                                             |                       |                    |                                   |                                      |              |
| i.                  | Type                                                                                         |                       |                    |                                   |                                      |              |
| ii.                 | Tracking index                                                                               |                       |                    |                                   |                                      |              |
| e.                  | Clearance                                                                                    |                       |                    |                                   |                                      |              |
| i.                  | Phase to phase                                                                               |                       |                    | mm                                |                                      |              |
| ii.                 | Phase to earth                                                                               |                       |                    | mm                                |                                      |              |
| f.                  | Flexibles                                                                                    |                       |                    | Size/Qty                          |                                      |              |
| g.                  | Earth bus material/size                                                                      |                       |                    |                                   |                                      |              |
|                     |                                                                                              |                       |                    |                                   |                                      |              |
|                     |                                                                                              |                       |                    |                                   |                                      |              |
| B                   | 08-SEP-2021                                                                                  | ISSUED WITH MR/TENDER | V V S N MURTY      | ANIL KUMAR GARHWAL                | HARISH KUMAR                         |              |
| A                   | 12-MAY-2020                                                                                  | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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> |  | <b>Job No.</b>  | B269                                 |
|                |                                                                                               |                 |  | <b>Unit No.</b> | 999                                  |
| h.             | Heat shrinkable sleeves rated to withstand the system line to line voltage for 1 min provided |                 |  |                 |                                      |
| i.             | Removable FRP shrouds for all busbars joints provided                                         |                 |  |                 |                                      |
| 8.             | Space heater provided                                                                         |                 |  |                 |                                      |
| 9.             | Overall dimensions(LxBxH)                                                                     |                 |  |                 |                                      |
| 10.            | Weight of each section of busduct                                                             |                 |  |                 |                                      |
| 11.            | Type test certificates                                                                        |                 |  |                 |                                      |
|                | Short ckt(Peak & 1 sec withstand)                                                             |                 |  |                 |                                      |
|                | Temperature rise                                                                              |                 |  |                 |                                      |
|                | Voltage withstandability                                                                      |                 |  |                 |                                      |

**Eil Notes**

- 1 Bus duct offered shall be of proven design and shall have been successfully type tested.Type test certificates for an exactly identical design of offered bus duct shall be furnished by bidders.
- 2 Rubber bellows shall not used for alignment /adjustments.

|          |             |                       |                    |                    |              |
|----------|-------------|-----------------------|--------------------|--------------------|--------------|
|          |             |                       |                    |                    |              |
| B        | 08-SEP-2021 | ISSUED WITH MR/TENDER | V V S N MURTY      | ANIL KUMAR GARHWAL | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | HARISH KUMAR       | HARISH KUMAR |
| Rev. No. | Date        | Purpose               | Prepared By        | Reviewed By        | Approved By  |

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| PROJECT: PANIPAT REFINERY EXPANSION(P-25) |  | REV. | DATE       | PURPOSE               | BY  | CHKD    | APPD. |
|-------------------------------------------|--|------|------------|-----------------------|-----|---------|-------|
| CLIENT: M/S IOCL                          |  | A    | 05.05.2020 | ISSUED WITH MR/TENDER | JLC | HK      | HK    |
|                                           |  | B    | 13.09.2021 | ISSUED WITH MR/TENDER | SNM | AKG/RSR | HK    |

D.C. CONTROL BUS

240VA.C. SPACE HEATER & AUX. CKT. BUS

H.V.BUS

INTER TRIP FROM SENDING END BKR.

1

10

86

22

25

11

23

27

33

25

51

6

51N

7

8a

64R

4A

REF

15

V

16

A

17

PF

18

F

19

MWH

29

MVAH

30

MVAR

31

MVA

32

MW

34

MFM

12

24

27U

13

2

14,14a

9

1A

4B

51G

8b

TO 87B IN B/C PANEL

TO SYSTEM EARTHING

CL.PS

CL.5P10

TO TRANSF.&FEEDER DIFF. PROT. IN U/S SWBD

BY SW.GR. VENDOR

BY OTHERS

(Note-5)

NOTE:

1. ANTIPUMPING 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 SPECIFICATION 6-51-0001 SHALL BE IN VENDOR'S SCOPE.

3. VA BURDEN OF CT & PT SHALL BE DECIDED BY VENDOR EXCEPT METERING CT.

4. ALL PROTECTION RELAYS SHALL BE NUMERICAL TYPE.

5. BUSDUCT SHALL BE PROVIDED, IF SPECIFIED IN RESPECTIVE SWITCHBOARD DATA SHEETS/ DESIGN BASIS.

6. DIGITAL MULTIFUNCTION METERS SHALL BE PROVIDED WITH  
1 NO. VOLTMETER (3PHASE), 1 NO. AMMETER (3PHASE),  
1 NO. PF METER (0.5 LAG-1.0-0.5 LEAD), 1NO. FREQUENCY METER (45 TO 55 HZ), 1 NO. MWH METER

7. FOR TRANSFORMER FEEDER DIFFERENTIAL PROTECTION, VENDOR/CONTRACTOR SHALL SUPPLY IDENTICAL RATED CTs AS THAT OF UPSTREAM SWITCHBOARD. FOR DETAILS REFER INSTRUCTIONS TO BIDDER (TR-0010).

8. THERE SHALL BE ONE COMMON CONTROL SWITCH FOR ALL CONTROL SUPPLY TO THE FEEDER. SEPARATE FUSES FOR FOLLOWING BRANCH CIRCUIT SHALL BE PROVIDED:  
• SPRING CHARGING CIRCUIT  
• CLOSING CIRCUIT  
• TRIPPING, CONTACT MULTIPLIER & DIGITAL INPUT CIRCUIT  
• INDICATION CIRCUIT  
• NUMERICAL RELAY SUPPLY (INCOMING OF NUMERICAL RELAY SUPPLY FUSE SHALL BE TAPPED BEFORE THE CONTROL SUPPLY SWITCH)

EQUIPMENT DATA

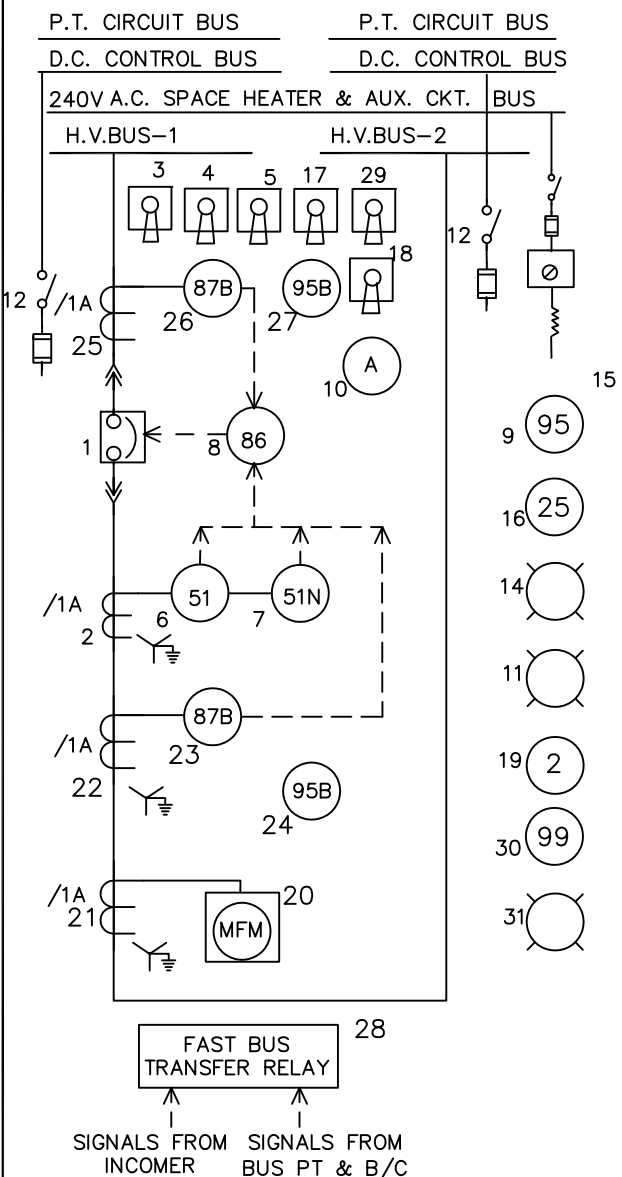
| ITEM NO. | NEMA NO. | QTY.     | DESCRIPTION                                                                  |
|----------|----------|----------|------------------------------------------------------------------------------|
| 1        | 52       | 1        | CIRCUIT BREAKER                                                              |
| 2        | -        | 3        | TRANSF. DIFF. C.T. CI.-PS                                                    |
| 3        | -        | 3        | METERING/PROTECTION C.T. CI.-5P10                                            |
| 4A       | -        | 3        | PROTECTION C.T. FOR REF PROT. CI.-PS                                         |
| 4B       | -        | 3        | PROTECTION C.T. FOR 87B PROT. CI.-PS                                         |
| 5        | 52 C/S   | 1        | BKR. CONTROL SW. CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL) |
| 6        | 51       | 2        | IDMTL O/C RELAY (50-200%)                                                    |
| 7        | 51N      | 1        | IDMTL E/F RELAY (10-40%)                                                     |
| 8a       | 64R      | 1        | INST. E/F RELAY (WITH STABILISING RESISTOR) (10-40%)                         |
| 8b       | 51G      | 1        | IDMTL O/C RELAY (20-80%)                                                     |
| 9        | -        | 3        | METERING CT CLASS 1.0, 15VA                                                  |
| 10       | 86       | 1        | TRIPPING RELAY (ELECTRO MECHANICAL)                                          |
| 11       | 95       | 1        | TRIP CKT. SUPERVISION RELAY                                                  |
| 12       | -        | 3        | Y/Y CONNECTED, CI.-1, P.T. WITH 110V SECONDARY WITH PRIMARY FUSE $\sqrt{3}$  |
| 13       | 27U      | 3        | U/V RELAY (40-80%)                                                           |
| 14       | 2        | 1        | TIME DELAY ON PICK UP TIMER 0.5-5.0 SEC.                                     |
| 14a      | 2        | 1        | TIME DELAY ON DROP-OFF TIMER 0.5-5.0 SEC.                                    |
| 15       | -        | 1        | VOLTMETER (3PHASE)                                                           |
| 16       | -        | 1        | AMMETER (3PHASE)                                                             |
| 17       | -        | 1        | PF METER 0.5LAG-1.0-0.5LEAD                                                  |
| 18       | -        | 1        | FREQUENCY METER 45 TO 55Hz                                                   |
| 19       | -        | 1        | MWH METER                                                                    |
| 20       | -        | AS REQD. | AUX. RELAY                                                                   |
| 21       | -        | 1        | CUBICLE LAMP WITH SWITCH & FUSE                                              |
| 22       | -        | 1        | D.P. SWITCH 10A WITH FUSE FOR D.C. CONTROL SUPPLY                            |
| 23       | -        | AS REQD. | CLUSTER LED TYPE INDICATING LAMP                                             |
| 24       | -        | 1        | 4 POLE MCB 10A.                                                              |
| 25       | -        | 1        | PANEL SPACE HEATER WITH SWITCH, FUSE AND THERMOSTAT.                         |
| 26       | -        | 1        | UPSTREAM BREAKER TRIP SWITCH (2 POSITION)(STAYPUT & LOCKABLE)                |
| 27       | -        | 3        | CLUSTER LED TYPE IND. LAMP (TRAFO. TROUBLE, UP STREAM BREAKER ON/OFF)        |
| 28       | 87T+F    | 1        | TRAFO. DIFFERENTIAL RELAY WITH STABILISING RESISTOR AND METROSIL(NOTE-7)     |
| 29       | -        | 1        | MVAH METER                                                                   |
| 30       | -        | 1        | MVAR METER                                                                   |
| 31       | -        | 1        | MVA METER                                                                    |
| 32       | -        | 1        | MWH METER                                                                    |
| 33       | 25       | 1        | SYNCH. CHECK RELAY                                                           |
| 34       | -        | 1        | DIGITAL MUTLIFUNCTION METER                                                  |
| 35       | -        | 1        | LOCAL/ECS SELECTOR SWITCH                                                    |

EQUIPMENT DATA

| ITEM NO. | NEMA NO. | QTY.     | DESCRIPTION                                                                             |
|----------|----------|----------|-----------------------------------------------------------------------------------------|
| 1        | 52       | 1        | CIRCUIT BREAKER                                                                         |
| 2        | -        | 3        | TRANSF. DIFF. C.T. CI.-PS                                                               |
| 3        | -        | 3        | METERING/PROTECTION C.T. CI.-5P10                                                       |
| 4A       | -        | 3        | PROTECTION C.T. FOR REF PROT. CI.-PS                                                    |
| 4B       | -        | 3        | PROTECTION C.T. FOR 87B PROT. CI.-PS                                                    |
| 5        | 52 C/S   | 1        | BKR. CONTROL SW. CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL)            |
| 6        | 51       | 2        | IDMTL O/C RELAY (50-200%)                                                               |
| 7        | 51N      | 1        | IDMTL E/F RELAY (10-40%)                                                                |
| 8a       | 64R      | 1        | INST. E/F RELAY (WITH STABILISING RESISTOR) (10-40%)                                    |
| 8b       | 51G      | 1        | IDMTL O/C RELAY (20-80%)                                                                |
| 9        | -        | 3        | METERING CT CLASS 1.0, 15VA                                                             |
| 10       | 86       | 1        | TRIPPING RELAY (ELECTRO MECHANICAL)                                                     |
| 11       | 95       | 1        | TRIP CKT. SUPERVISION RELAY                                                             |
| 12       | -        | 3        | Y/Y CONNECTED, CI.-1, P.T. WITH 110V SECONDARY WITH PRIMARY FUSE $\frac{110}{\sqrt{3}}$ |
| 13       | 27U      | 3        | U/V RELAY (40-80%)                                                                      |
| 14       | 2        | 1        | TIME DELAY ON PICK UP TIMER 0.5-5.0 SEC.                                                |
| 14a      | 2        | 1        | TIME DELAY ON DROP-OFF TIMER 0.5-5.0 SEC.                                               |
| 15       | -        | 1        | VOLTMETER (3PHASE)                                                                      |
| 16       | -        | 1        | AMMETER (3PHASE)                                                                        |
| 17       | -        | 1        | PF METER 0.5LAG-1.0-0.5LEAD                                                             |
| 18       | -        | 1        | FREQUENCY METER 45 TO 55Hz                                                              |
| 19       | -        | 1        | MWH METER                                                                               |
| 20       | -        | AS REQD. | AUX. RELAY                                                                              |
| 21       | -        | 1        | CUBICLE LAMP WITH SWITCH & FUSE                                                         |
| 22       | -        | 1        | D.P. SWITCH 10A WITH FUSE FOR D.C. CONTROL SUPPLY                                       |
| 23       | -        | AS REQD. | CLUSTER LED TYPE INDICATING LAMP                                                        |
| 24       | -        | 1        | 4 POLE MCB 10A.                                                                         |
| 25       | -        | 1        | PANEL SPACE HEATER WITH SWITCH, FUSE AND THERMOSTAT.                                    |
| 26       | -        | 1        | UPSTREAM BREAKER TRIP SWITCH (2 POSITION)(STAYPUT & LOCKABLE)                           |
| 27       | -        | 3        | CLUSTER LED TYPE IND. LAMP (TRAFO. TROUBLE, UP STREAM BREAKER ON/OFF)                   |
| 28       | 87T+F    | 1        | TRAFO. DIFFERENTIAL RELAY WITH STABILISING RESISTOR AND METROSIL(NOTE-7)                |
| 29       | -        | 1        | MVAH METER                                                                              |
| 30       | -        | 1        | MVAR METER                                                                              |
| 31       | -        | 1        | MVA METER                                                                               |
| 32       | -        | 1        | MWH METER                                                                               |
| 33       | 25       | 1        | SYNCH. CHECK RELAY                                                                      |
| 34       | -        | 1        | DIGITAL MUTLIFUNCTION METER                                                             |
| 35       | -        | 1        | LOCAL/ECS SELECTOR SWITCH                                                               |

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| PROJECT: PANIPAT REFINERY EXPANSION(P-25) | REV | DATE       | PURPOSE               | BY  | CHKD    | APPD |
|-------------------------------------------|-----|------------|-----------------------|-----|---------|------|
| CLIENT: M/S IOCL                          | A   | 05.05.2020 | ISSUED WITH MR/TENDER | JLC | HK      | HK   |
|                                           | B   | 13.09.2021 | ISSUED WITH MR/TENDER | SNM | AKG/RSR | HK   |



- R1 PART OF NUMERICAL RELAY-1  
R2 PART OF NUMERICAL RELAY-2  
R3 PART OF NUMERICAL RELAY-3  
R4 PART OF NUMERICAL RELAY-4

- NOTE:
1. ANTIPUMPING 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 SPECIFICATION 6-51-0001 SHALL BE IN VENDOR'S SCOPE.
  3. A-I-M AND TRIP A-T-B SELECTOR SWITCHES SHALL BE PROVIDED IF AUTO TRANSFER REQUIREMENT IS SPECIFIED IN RESPECTIVE SWITCHBOARD DATASHEET.
  4. ALL PROTECTION RELAY SHALL BE NUMERICAL TYPE
  5. VA BURDEN OF CT SHALL BE DECIDED BY VENDOR.
  6. DIGITAL MULTIFUNCTION METERS SHALL BE PROVIDED WITH 1 NO. AMMETER (3PHASE).
  7. MANUAL BYPASS FEATURE SHALL BE PROVIDED FOR BUS DIFFERENTIAL FOR BOTH BUS SECTIONS INDEPENDENTLY.
  8. THERE SHALL BE ONE COMMON CONTROL SWITCH FOR ALL CONTROL SUPPLY FEEDER. SEPARATE FUSES FOR FOLLOWING BRANCH CIRCUIT SHALL BE PROVIDED:
    - SPRING CHARGING CIRCUIT
    - CLOSING CIRCUIT
    - TRIPPING, CONTACT MULTIPLIER & DIGITAL INPUT CIRCUIT
    - INDICATION CIRCUIT
    - NUMERICAL RELAY SUPPLY (INCOMING OF NUMERICAL RELAY SUPPLY FUSE SHALL BE TAPPED BEFORE THE CONTROL SUPPLY SWITCH)

| EQUIPMENT DATA |          |          |                                                                                                                |
|----------------|----------|----------|----------------------------------------------------------------------------------------------------------------|
| ITEM NO        | NEMA NO. | QTY.     | DESCRIPTION                                                                                                    |
| 1              | 52       | 1        | CIRCUIT BREAKER                                                                                                |
| 2              | -        | 3        | METERING / PROTECTION C.T. CI.-1/5P10                                                                          |
| 3              | -        | 1        | BREAKER CONTROL SWITCH CLOSE-NEUTRAL TRIP ( SPRING RETURN TO NEUTRAL)                                          |
| 4              | -        | 1        | AUTO-IND-MANUAL SELECTOR SWITCH (STAYPUT & LOCKABLE)                                                           |
| 5              | -        | 1        | 3 POSITION SW. FOR TRIP BKR.-A/TRIP TIE/ TRIP BKR.-B (STAYPUT & LOCKABLE)                                      |
| 6              | 51       | 2        | IDMTL O/C RELAY (50-200%) OR APPD. EQUIV.                                                                      |
| 7              | 51N      | 1        | IDMTL E/F RELAY (10-40%)                                                                                       |
| 8              | 86       | 1        | TRIPPING RELAY (ELECTRO MECHANICAL)                                                                            |
| 9              | 95       | 1        | TRIP CKT. SUPERVISION RELAY                                                                                    |
| 10             | 95B      | 1        | AMMETER (3 PHASE)                                                                                              |
| 11             | -        | 1        | CUBICLE LAMP WITH SWITCH AND FUSE                                                                              |
| 12             | -        | 2        | DP SWITCH 10A WITH FUSE FOR D.C. CONTROL SUPPLY (NOTE-8)                                                       |
| 13             | -        | AS REQD. | AUX. RELAY                                                                                                     |
| 14             | -        | AS REQD. | CLUSTER LED TYPE INDICATING LAMP                                                                               |
| 15             | -        | 1        | PANEL SPACE HEATER WITH SWITCH FUSE & THERMOSTAT                                                               |
| 16             | 25       | 1        | SYNCH.CHECK RELAY                                                                                              |
| 17             | -        | 1        | 32A/63A DC CONTROL SUPPLY CHANGEOVER SWITCH(4 POSITION)                                                        |
| 18             | -        | 1        | 32A AC CONTROL SUPPLY CHANGEOVER SWITCH ( 4 POSITION)                                                          |
| 19             | 2        | AS REQD. | ON/OFF DELAY TIMER                                                                                             |
| 20             | -        | 1        | DIGITAL MULTIFUNCTION METER                                                                                    |
| 21             | -        | 3        | METERING CT CLASS 1.0                                                                                          |
| 22             | -        | 3        | PROTECTION C.T. FOR 87B PROT. CI.-PS                                                                           |
| 23             | 87B      | 1        | HIGH IMPEDANCE BUSBAR DIFF. PROTECTION RELAY ALONG WITH CT SUPERVISION RELAY FOR COMPLETE BUS SECTION (NOTE-7) |
| 24             | 95B      | 1        | BUS WIRE SUPERVISION RELAY FOR COMPLETE BUS SECTION                                                            |
| 25             | -        | 3        | PROTECTION C.T. FOR 87B PROT. CI.-PS                                                                           |
| 26             | 87B      | 1        | HIGH IMPEDANCE BUSBAR DIFF. PROTECTION RELAY ALONG WITH CT SUPERVISION RELAY FOR COMPLETE BUS SECTION (NOTE-7) |
| 27             | 95B      | 1        | BUS WIRE SUPERVISION RELAY FOR COMPLETE BUS SECTION                                                            |
| 28             | -        | 1        | FAST BUS TRANSFER RELAY ALONG WITH ALL OTHER ACCESSORIES AS REQUIRED                                           |
| 29             | -        | 1        | LOCAL/ECS SELECTOR SWITCH                                                                                      |
| 30             | -        | 1        | CLOSING CIRCUIT SUPERVISION                                                                                    |
| 31             | -        | 1        | CLOSING CKT. HEALTHY INDICATION LAMP LAMP(LED TYPE)                                                            |



ENGINEERS INDIA LIMITED  
NEW DELHI

6.6KV SWITCHBOARD  
HARDWARE DATASHEET FOR  
BUSCOUPLER WITH FAST BUS

TECHNICAL AMENDMENT NO. 01

DATA SHEET

REV

B269-999-16-50-DS-0005

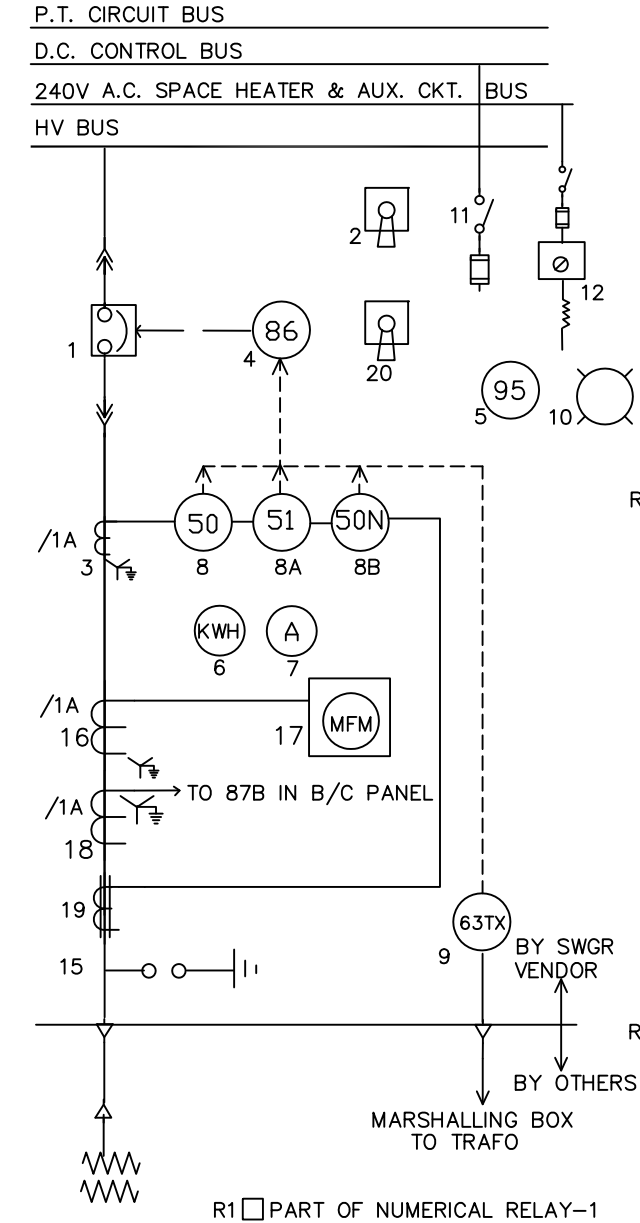
SHT 1 OF 114

B



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| REV | DATE       | PURPOSE               | BY  | CHKD    | APPD |
|-----|------------|-----------------------|-----|---------|------|
| A   | 05.05.2020 | ISSUED WITH MR/TENDER | JLC | HK      | HK   |
| B   | 13.09.2021 | ISSUED WITH MR/TENDER | SNM | AKG/RSR | HK   |



| EQUIPMENT DATA |          |          |                                                                      |
|----------------|----------|----------|----------------------------------------------------------------------|
| ITEM NO        | NEMA NO. | QTY.     | DESCRIPTION                                                          |
| 1              | 52       | 1        | CIRCUIT BREAKER                                                      |
| 2              | -        | 1        | BREAKER CONTROL SWITCH CLOSE-NEUTRAL-TRIP (SPRING RETURN TO NEUTRAL) |
| 3              | -        | 3        | PROTECTION C.T. CI.-5P10                                             |
| 4              | 86       | 1        | TRIPPING RELAY (ELECTRO MECHANICAL)                                  |
| 5              | 95 95B   | 1        | TRIP CKT. SUPERVISION RELAY                                          |
| 6              | -        | 1        | KWH METER                                                            |
| 7              | -        | 1        | AMMETER(3 PHASE)                                                     |
| 8              | 50       | 2        | INSTANTANEOUS O/C RELAY (500-2000%)                                  |
| 8A             | 51       | 2        | IDMTL O/C RELAY (50-200%)                                            |
| 8B             | 50N      | 1        | INSTANTANEOUS E/F RELAY (10-40%) WITH STABILISING RESISTOR           |
| 9              | 63TX     | 3        | AUX. RELAY FOR TRANSF. TROUBLE/TRIP (HAND RESET - 8 SIGNALS)         |
| 10             | -        | AS REQD  | CLUSTER LED TYPE INDICATING LAMP                                     |
| 11             | -        | 1        | DP SWITCH 10A WITH FUSE FOR DC CONTROL SUPPLY (NOTE-7)               |
| 12             | -        | 1        | PANEL SPACE HEATER WITH SWITCH, FUSE AND THERMOSTAT.                 |
| 13             | -        | 1        | CUBICLE LAMP (CFL) WITH SWITCH & FUSE                                |
| 14             | -        | AS REQD. | AUX.RELAY                                                            |
| 15             | -        | 1SET     | METAL OXIDE TYPE SURGE SUPPRESSOR                                    |
| 16             | -        | 3        | METERING CT CLASS 1.0                                                |
| 17             | -        | 1        | DIGITAL MULTIFUNCTION METER                                          |
| 18             | -        | 3        | PROTECTION C.T. FOR 87B PROT. CI.-PS                                 |
| 19             | -        | 1        | CORE BALANCE CURRENT TRANSFORMER                                     |
| 20             | -        | 1        | LOCAL/ECS SELECTOR SWITCH                                            |

NOTE:

1. ANTIPUMPING 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 SPECIFICATION 6-51-0001 SHALL BE IN VENDOR'S SCOPE.
3. ALL PROTECTION RELAYS SHALL BE NUMERICAL TYPE.
4. VA BURDEN OF CT & PT SHALL BE DECIDED BY VENDOR WHERE NOT INDICATED.
5. DIGITAL MULTIFUNCTION METERS SHALL BE PROVIDED WITH 1 NO. AMMETER (3PHASE), 1 NO. MWH METER, 1 NO. MW METER
6. THERE SHALL BE ONE COMMON CONTROL SWITCH FOR ALL CONTROL SUPPLY FEEDER. SEPARATE FUSES FOR FOLLOWING BRANCH CIRCUIT SHALL BE PROVIDED:
  - SPRING CHARGING CIRCUIT
  - CLOSING CIRCUIT
  - TRIPPING, CONTACT MULTIPLIER & DIGITAL INPUT CIRCUIT
  - INDICATION CIRCUIT
  - NUMERICAL RELAY SUPPLY (INCOMING OF NUMERICAL RELAY SUPPLY FUSE SHALL BE TAPPED BEFORE THE CONTROL SUPPLY SWITCH)



ENGINEERS INDIA LIMITED  
NEW DELHI

6.6KV SWITCHBOARD  
HARDWARE DATASHEET FOR  
TRANSFORMER FEEDER

TECHNICAL AMENDMENT NO. 01

DATA SHEET

REV

B269-999-16-50-DS-0006  
SHT 1 OF 1

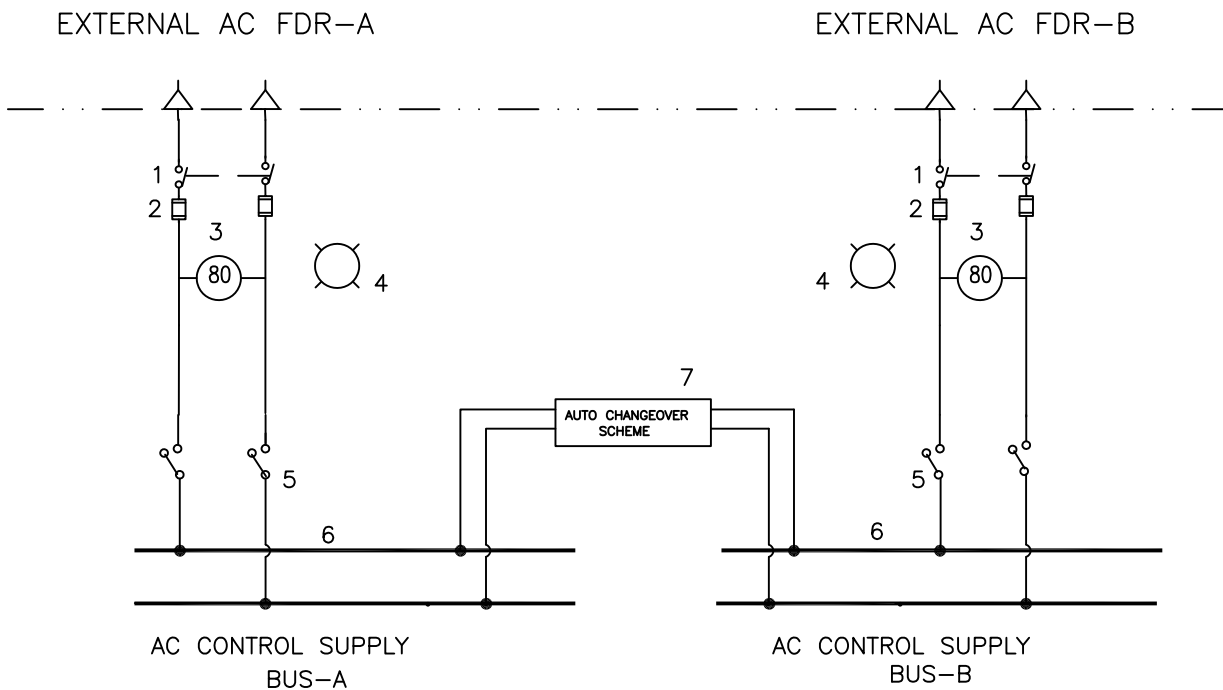
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|                                                               |     |            |                       |     |      |       |
|---------------------------------------------------------------|-----|------------|-----------------------|-----|------|-------|
| PROJECT: PANIPAT REFINERY EXPANSION(P-25)<br>CLIENT: M/S IOCL | REV | DATE       | PURPOSE               | BY  | CHKD | APPRV |
|                                                               | A   | 05.05.2020 | ISSUED WITH MR/TENDER | JLC | HK   | HK    |
|                                                               | B   | 08.09.2021 | ISSUED WITH MR/TENDER | SNM | AKG  | HK    |



| EQUIPMENT DATA (FOR EACH AC BUS SECTION) |          |         |                                                                         |
|------------------------------------------|----------|---------|-------------------------------------------------------------------------|
| ITEM NO.                                 | NEMA NO. | QTY.    | DESCRIPTION                                                             |
| 1                                        | —        | 1       | DP SWITCH 25A (MIN)                                                     |
| 2                                        | —        | 2       | HRC FUSE                                                                |
| 3                                        | 80       | 1       | AC SUPPLY FAILURE RELAY (30–60%) WITH 2NO + 2NC CONTACTS FOR OWNERS USE |
| 4                                        | —        | 1       | INDICATING LAMP – LED TYPE                                              |
| 5                                        | —        | 1       | CONTROL (ON/OFF) SWITCH                                                 |
| 6                                        | —        | 3       | AC CONTROL SUPPLY BUS                                                   |
| 7                                        | —        | AS REQD | ALL COMPONENTS FOR AUTO CHANGEOVER SCHEME                               |

NOTES:

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
2. THE COMPONENT RATING ARE INDICATIVE AND SAME SHALL BE SIZED BASED ON AC POWER REQUIREMENT OF THE SWITCHBOARD BY THE VENDOR. ALL RELAYS SHALL BE NUMERICAL TYPE.
3. IN NORMAL CONDITION, EACH AC FEEDER SHALL BE FEEDING RESPECTIVE AC BUS. IN CASE OF TRIPPING OF ONE INCOMER, AUTO-CHANGEOVER SHALL TAKE PLACE SO THAT COMPLETE BUS SECTION CAN BE FED FROM HEALTHY SOURCE. ONCE POWER IS AGAIN AVAILABLE AT BOTH INCOMERS, RESTORATION SHALL BE DONE SO THAT THERE IS NO LOSS OF CONTROL POWER.
4. THE CHANGEOVER SCHEME SHALL BE 'MAKE BEFORE BREAK TYPE'.



ENGINEERS INDIA LIMITED  
NEW DELHI

HARDWARE DATASHEET FOR  
CHANGEOVER SCHEME FOR AC  
CONTROL SUPPLY  
FOR HV AND MV SWITCHBOARD  
TECHNICAL AMENDMENT NO. 01

DATA SHEET

REV

B269-999-16-50-DS-0010

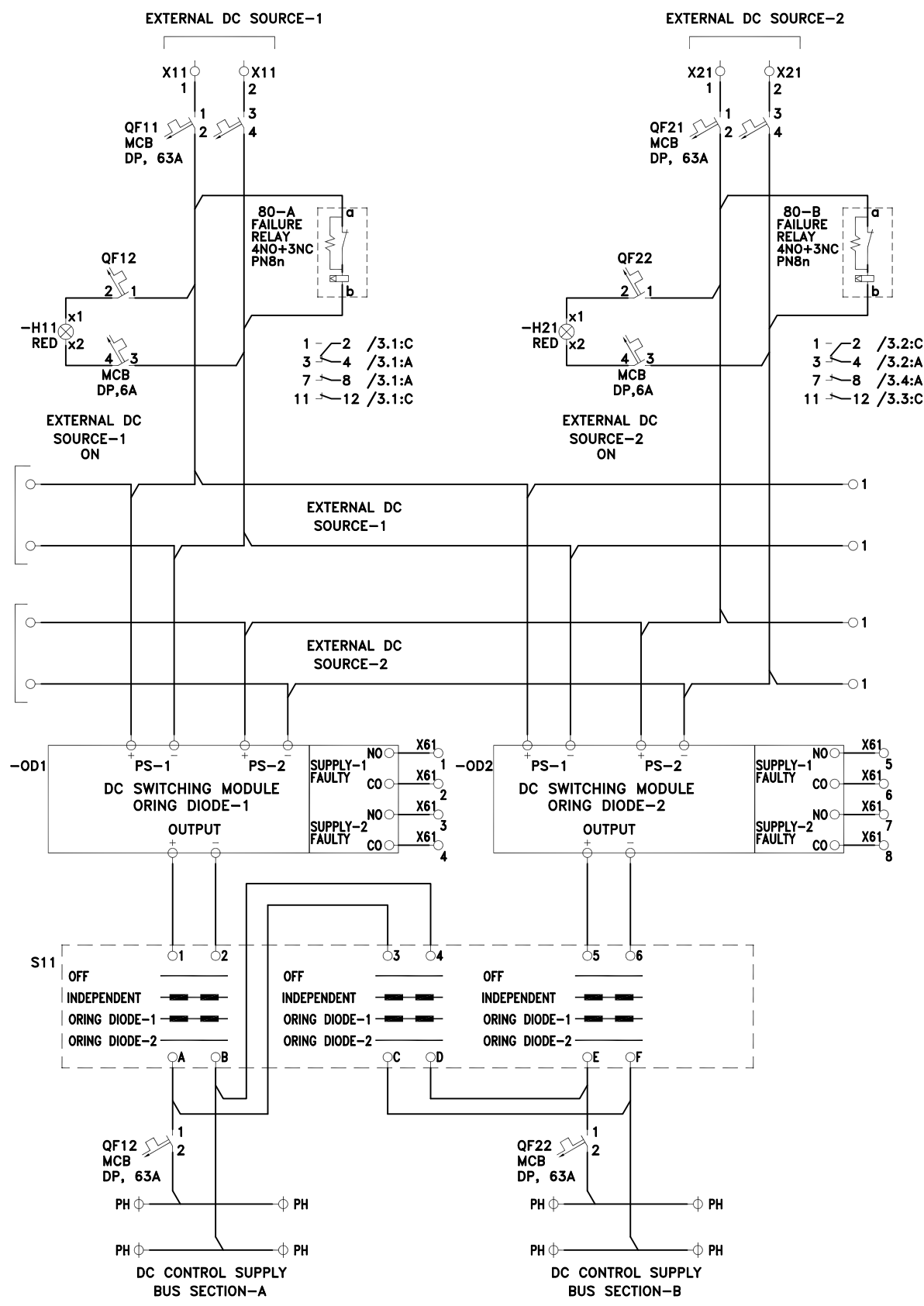
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Sheet 1 of 2

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|                                          |     |            |                |     |         |      |
|------------------------------------------|-----|------------|----------------|-----|---------|------|
| PROJECT: P25 PROJECT<br>CLIENT: M/s IOCL | REV | DATE       | PURPOSE        | BY  | CHKD    | APPD |
|                                          | B   | 13.09.2021 | ISSUED WITH MR | SNM | AKG/RSR | HK   |



ENGINEERS INDIA LIMITED  
NEW DELHI

DC SUPPLY  
AUTO CHANGEOVER  
FOR SWBD  
TECHNICAL AMENDMENT NO. 01

DATA SHEET

REV

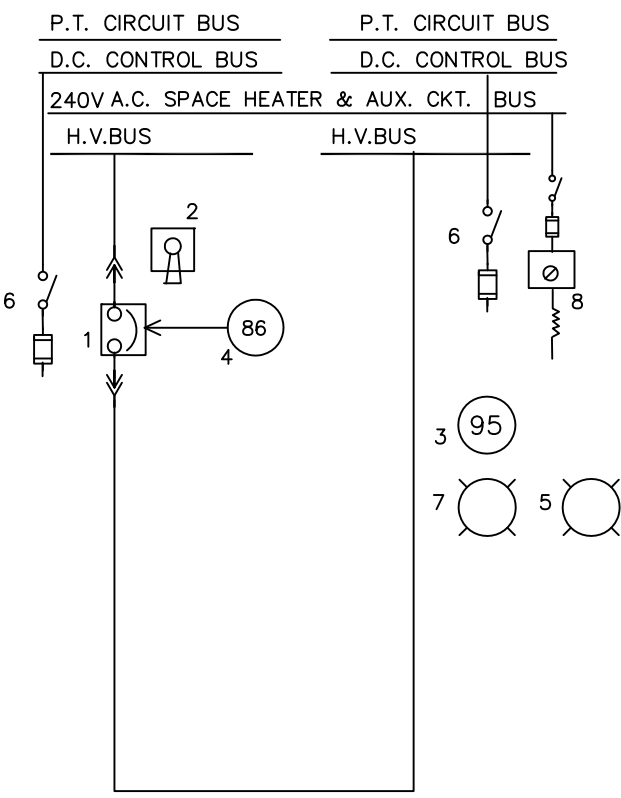
B269-999-16-50-DS-0010  
SHT 2 OF 2

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|                                                               |     |            |                       |     |      |      |
|---------------------------------------------------------------|-----|------------|-----------------------|-----|------|------|
| PROJECT: PANIPAT REFINERY EXPANSION(P-25)<br>CLIENT: M/S IOCL | REV | DATE       | PURPOSE               | BY  | CHKD | APPD |
|                                                               | A   | 05.05.2020 | ISSUED WITH MR/TENDER | JLC | HK   | HK   |
|                                                               | B   | 08.09.2021 | ISSUED WITH MR/TENDER | SNM | AKG  | HK   |



| EQUIPMENT DATA |          |          |                                                                      |
|----------------|----------|----------|----------------------------------------------------------------------|
| ITEM NO        | NEMA NO. | QTY.     | DESCRIPTION                                                          |
| 1              | 52       | 1        | CIRCUIT BREAKER                                                      |
| 2              | -        | 1        | BREAKER CONTROL SWITCH CLOSE-NEUTRAL TRIP (SPRING RETURN TO NEUTRAL) |
| 3              | 95       | 1        | TRIP CKT. SUPERVISION RELAY (CONVENTIONAL)                           |
| 4              | 86       | 1        | TRIPPING RELAY (CONVENTIONAL)                                        |
| 5              | -        | 1        | CUBICLE LAMP WITH SWITCH AND FUSE                                    |
| 6              | -        | 2        | DP SWITCH 10A WITH FUSE FOR D.C. CONTROL SUPPLY                      |
| 7              | -        | AS REQD. | CLUSTER LED TYPE INDICATING LAMP                                     |
| 8              | -        | 1        | PANEL SPACE HEATER WITH SWITCH FUSE & THERMOSTAT                     |

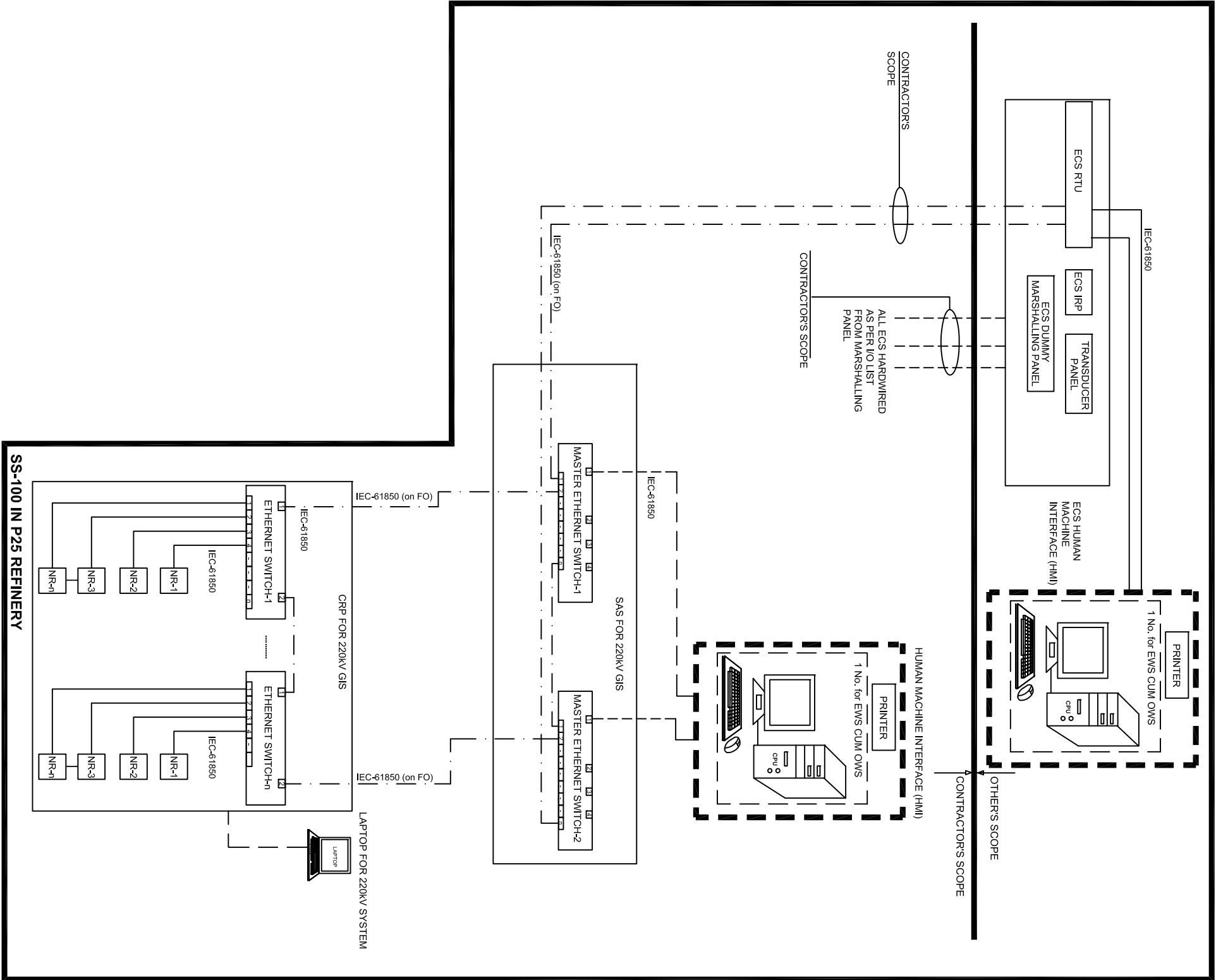
- NOTE:
1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
  2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE . ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0001 SHALL BE IN VENDOR'S SCOPE.
  3. THERE SHALL BE ONE COMMON CONTROL SWITCH FOR ALL CONTROL SUPPLY FEEDER. SEPARATE FUSES FOR FOLLOWING BRANCH CIRCUIT SHALL BE PROVIDED:
    - SPRING CHARGING CIRCUIT
    - CLOSING CIRCUIT
    - TRIPPING AND CONTACT MULTIPLIER CIRCUIT
    - INDICATION CIRCUIT





NOTES

1. System architecture defines basic requirement of numerical relays integration with HMI & Electrical Control System (ECS) as a part of substation automation. Detailed architecture shall be developed by Contractor or their selected manufacturer.
2. System shall be engineered such that any board can be taken out for maintenance or removed without affecting communication with other boards.
3. Protocol shall be IEC 61850-RSTP providing all functionalities such as protection, control, relay parameterization, time synchronization, down loading disturbance record etc. Protocol for communication to ECS-RTU shall IEC 61850.
4. Scope split between Owner and Contractor, refer Job Specification attached with bid document. Interface cabling between ECS-RTU and ECS I/F panels shall be done by Owner/ Other Contractor.
5. LAPTOP along with programming and application software shall be supplied as required with license.
6. The supplied architecture should, in addition to this architecture, meet the requirement of numerical relay data sheet, Job Specification and EIL Specification 6-51-0055 attached with the bid document.
7. The communication protocol between Numerical relay and Ethernet Switches shall be IEC-61850.
8. The communication protocol between Ethernet switches and ECS RTU panel shall be IEC-61850.
9. CONTRACTOR shall furnish detailed system architecture drawing giving explicit details of protocol, redundancy and topology in line with Tender requirements.
10. Human Machine Interface-HMI/ shall communicate with Ethernet switches over IEC-61850 Protocol.
11. Refer clause no. 6.1.2 & Figure No.-02 of attached specification for Numerical relay & Substation Automation System Doc. No. (6-51-0055) for system configuration details.
12. ICD files shall be provided for IEDs (relays etc.)/ any other device as required by vendor as the same shall be required by ECS vendor for configuration purpose during detailed engineering.
13. GPS and antenna shall be provided in each substation for time synchronization as per Tender requirement.



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ENGINEERS INDIA LIMITED  
NEW DELHI

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

| REV. | DATE       | ISSUED WITH TENDER               | BY  | CHK | APPROVED | APPROVED |
|------|------------|----------------------------------|-----|-----|----------|----------|
| A    | 12.05.2020 | ISSUED WITH TENDER               | AKG | HK  | HK       |          |
| B    | 05.07.2021 | REVISED AND REISSUED WITH TENDER | AKG | HK  | HK       |          |
| C    | 11.04.2022 | REVISED AND REISSUED WITH TENDER | RG  | HK  | HK       |          |

BLOCK DIAGRAM FOR  
NUMERICAL RELAY LAN & SUBSTATION  
AUTOMATION SYSTEM  
220kV GAS INSULATED SWITCHBOARD  
(MRSS-100)

| DRAWING NO.            | REV. |
|------------------------|------|
| B269-999-16-50-DS-0052 | C    |

|                                                                                                                                                                  |                                                                                         |                                                             |                         |                                                                                   |                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------|-----------------------------------------------------------------------------------|--------------------------------------|
|  <b>ENGINEERS INDIA LIMITED</b><br><small>(A Govt. of India Undertaking)</small> |                                                                                         | <b>33kV HV ISOLATING BREAKER PANEL</b><br><b>DATA SHEET</b> |                         | <b>Document No.</b><br>B269-999-16-50-DS-0071<br><b>Rev. No.</b> C<br>Page 1 of 4 |                                      |
| <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>                                             |                         | <b>Job No.</b>                                                                    | B269                                 |
|                                                                                                                                                                  |                                                                                         |                                                             |                         | <b>Unit No.</b>                                                                   | 999                                  |
| <b>PURCHASER'S DATA</b>                                                                                                                                          |                                                                                         |                                                             |                         |                                                                                   |                                      |
| <b>A. Site Conditions</b>                                                                                                                                        |                                                                                         |                                                             |                         |                                                                                   |                                      |
| 1.                                                                                                                                                               | Maximum Ambient Temperature                                                             | °C                                                          | 50                      |                                                                                   |                                      |
| 2.                                                                                                                                                               | Minimum Ambient Temperature                                                             | °C                                                          | 5                       |                                                                                   |                                      |
| 3.                                                                                                                                                               | Design Ambient Temperature                                                              | °C                                                          | 45                      |                                                                                   |                                      |
| 4.                                                                                                                                                               | Relative Humidity                                                                       | %                                                           | 90                      |                                                                                   |                                      |
| 5.                                                                                                                                                               | Altitude Above MSL                                                                      | mm                                                          | 1000                    |                                                                                   |                                      |
| 6.                                                                                                                                                               | Environment                                                                             | Hot, Humid & Corrosive                                      |                         |                                                                                   |                                      |
| <b>B. Operating Conditions</b>                                                                                                                                   |                                                                                         |                                                             |                         |                                                                                   |                                      |
| 1.                                                                                                                                                               | Voltage                                                                                 | kV                                                          | 33 +/- 10 %             |                                                                                   |                                      |
| 2.                                                                                                                                                               | Frequency                                                                               | Hz                                                          | 50 +/- 3 %              |                                                                                   |                                      |
| 3.                                                                                                                                                               | No of phases                                                                            | Three                                                       |                         |                                                                                   |                                      |
| 4.                                                                                                                                                               | System fault level                                                                      | kA                                                          | 40                      |                                                                                   |                                      |
| 5.                                                                                                                                                               | System earthing                                                                         | Solidly Earthed                                             |                         |                                                                                   |                                      |
| 6.                                                                                                                                                               | Auxiliary supply                                                                        |                                                             |                         |                                                                                   |                                      |
|                                                                                                                                                                  | AC                                                                                      | V                                                           | 240 +/- 10 %            |                                                                                   |                                      |
|                                                                                                                                                                  | DC                                                                                      | V                                                           | 220 +/- 15 % / -10 % DC |                                                                                   |                                      |
| <b>C. Electrical Data</b>                                                                                                                                        |                                                                                         |                                                             |                         |                                                                                   |                                      |
| 1.                                                                                                                                                               | Busbar current rating (inside panel at design temp.)                                    | As per Job Specification                                    |                         |                                                                                   |                                      |
| 2.                                                                                                                                                               | 1 sec. Short Circuit withstand capacity                                                 | kA                                                          | 40                      |                                                                                   |                                      |
| 3.                                                                                                                                                               | System Breaking capacity                                                                | kA                                                          | 40                      |                                                                                   |                                      |
|                                                                                                                                                                  | % D.C. Component                                                                        | As per IEC                                                  |                         |                                                                                   |                                      |
| 4.                                                                                                                                                               | System making capacity                                                                  | kA(peak)                                                    | 100                     |                                                                                   |                                      |
| 5.                                                                                                                                                               | Type of Circuit Breaker                                                                 | VCB                                                         |                         |                                                                                   |                                      |
|                                                                                                                                                                  | Shunt Trip Coil-1 :                                                                     | V                                                           | 220 DC                  |                                                                                   |                                      |
|                                                                                                                                                                  | Shunt Trip Coil-2 :                                                                     | V                                                           | NotApplicable           |                                                                                   |                                      |
| 6.                                                                                                                                                               | Duty Cycle of C.B.                                                                      | O-3min-CO-3min-CO                                           |                         |                                                                                   |                                      |
| 7.                                                                                                                                                               | Suitability for Cap. Switching                                                          | Not Required                                                |                         |                                                                                   |                                      |
| 8.                                                                                                                                                               | Surge supressor for Motor Feeder.                                                       | No                                                          |                         |                                                                                   |                                      |
| 9.                                                                                                                                                               | Provision of earthing                                                                   |                                                             |                         |                                                                                   |                                      |
|                                                                                                                                                                  | Earthing truck                                                                          | Required                                                    |                         |                                                                                   |                                      |
|                                                                                                                                                                  | Earthing switch                                                                         | Not Required                                                |                         |                                                                                   |                                      |
| <b>D. Miscellaneous</b>                                                                                                                                          |                                                                                         |                                                             |                         |                                                                                   |                                      |
| 1.                                                                                                                                                               | Interface with ECS                                                                      | Required                                                    |                         |                                                                                   |                                      |
| 2.                                                                                                                                                               | Incoming Power Entry                                                                    | Cable                                                       |                         |                                                                                   |                                      |
| 3.                                                                                                                                                               | Cable Entry                                                                             | Bottom                                                      |                         |                                                                                   |                                      |
| 4.                                                                                                                                                               | Separate bolted removable gland palte for cable entry                                   | Reqd.(Gland Plate Drilled at side)                          |                         |                                                                                   |                                      |
| 5.                                                                                                                                                               | Cable glands and lugs for cable termination                                             | Included                                                    |                         |                                                                                   |                                      |
| 6.                                                                                                                                                               | Paint shade                                                                             | RAL-7032                                                    |                         |                                                                                   |                                      |
| 7.                                                                                                                                                               | Windows at the rear side of panels for thermography                                     | Required                                                    |                         |                                                                                   |                                      |
| <b>MANUFACTURER'S DATA</b>                                                                                                                                       |                                                                                         |                                                             |                         |                                                                                   |                                      |
| <b>A. Switchboards</b>                                                                                                                                           |                                                                                         |                                                             |                         |                                                                                   |                                      |
| 1.                                                                                                                                                               | Make                                                                                    |                                                             |                         |                                                                                   |                                      |
|                                                                                                                                                                  |                                                                                         |                                                             |                         |                                                                                   |                                      |
|                                                                                                                                                                  |                                                                                         |                                                             |                         |                                                                                   |                                      |
| C                                                                                                                                                                | 06-APR-2022                                                                             | REVISED & ISSUED WITH TENDER                                | RAHUL GANGULY           | HARISH KUMAR                                                                      | HARISH KUMAR                         |
| B                                                                                                                                                                | 14-JUL-2021                                                                             | ISSUED WITH MR                                              | 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>              |                    | <b>Job No.</b> | B269                                 | <b>Unit No.</b> 999 |
| 2.             | Type designation                                                                                                                                   |                              |                    |                |                                      |                     |
| 3.             | Degree of protection                                                                                                                               |                              |                    |                |                                      |                     |
| 4.             | Max. overall weight of C.B. panel                                                                                                                  |                              | Kg                 |                |                                      |                     |
| 5.             | Overall dimensions of C.B. panel                                                                                                                   |                              |                    |                |                                      |                     |
|                | Width                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Depth                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Height                                                                                                                                             |                              | mm                 |                |                                      |                     |
| 6.             | Overall dimensions of dummy / gland plate for cable entry                                                                                          |                              |                    |                |                                      |                     |
|                | Width                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Depth                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Height                                                                                                                                             |                              | mm                 |                |                                      |                     |
| 7.             | Overall weight and dimensions of largest shipping section                                                                                          |                              |                    |                |                                      |                     |
|                | Weight                                                                                                                                             |                              | Kg                 |                |                                      |                     |
|                | Width                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Depth                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Height                                                                                                                                             |                              | mm                 |                |                                      |                     |
| 8.             | Overall dimensions of each swbd. including all dummy/adaptor/rear extension panels                                                                 |                              |                    |                |                                      |                     |
|                | Width                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Depth                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Height                                                                                                                                             |                              | mm                 |                |                                      |                     |
| 9.             | Recommended clearances                                                                                                                             |                              |                    |                |                                      |                     |
|                | Front                                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Rear                                                                                                                                               |                              | mm                 |                |                                      |                     |
|                | Above                                                                                                                                              |                              | mm                 |                |                                      |                     |
| 10.            | Shock loading on foundation                                                                                                                        |                              |                    |                |                                      |                     |
| 11.            | Max. size/no. of cables that can be terminated inside the panel                                                                                    |                              |                    |                |                                      |                     |
|                | without rear extension panel                                                                                                                       |                              |                    |                |                                      |                     |
|                | with rear extension panel                                                                                                                          |                              |                    |                |                                      |                     |
|                | size of rear extension panel                                                                                                                       |                              |                    |                |                                      |                     |
| 12.            | Clearance in air                                                                                                                                   |                              |                    |                |                                      |                     |
|                | Phase to Phase (min.)                                                                                                                              |                              | mm                 |                |                                      |                     |
|                | Phase to Earth (min.)                                                                                                                              |                              | mm                 |                |                                      |                     |
| 13.            | Busbar current rating at design ambient temperature                                                                                                |                              | A                  |                |                                      |                     |
| 14.            | Busbar (separately for each swbd)                                                                                                                  |                              |                    |                |                                      |                     |
|                | (a).Horizontal main busbar size (No. of flats x size of each flat)                                                                                 |                              |                    |                |                                      |                     |
|                | (b).Horizontal main busbar size as tested at CPRI for full short ckt withstand as per specification requirement (No. of flats x size of each flat) |                              |                    |                |                                      |                     |
|                | (c).Vertical dropper size (No. of flats x size of each flat)                                                                                       |                              |                    |                |                                      |                     |
| 15.            | Horizontal main busbar/Vertical busbar material                                                                                                    |                              |                    |                |                                      |                     |
| 16.            | Insulating material (Busbar supports)                                                                                                              |                              |                    |                |                                      |                     |
| 17.            | Earth busbar size                                                                                                                                  |                              |                    |                |                                      |                     |
| 18.            | Earth busbar material                                                                                                                              |                              |                    |                |                                      |                     |
| 19.            | 1 min. power frequency withstand voltage (rms)                                                                                                     |                              | kV                 |                |                                      |                     |
|                | Over voltage factor for PTs                                                                                                                        |                              |                    |                |                                      |                     |
| 20.            | Impulse withstand voltage (peak)                                                                                                                   |                              | kV                 |                |                                      |                     |
|                |                                                                                                                                                    |                              |                    |                |                                      |                     |
|                |                                                                                                                                                    |                              |                    |                |                                      |                     |
| C              | 06-APR-2022                                                                                                                                        | REVISED & ISSUED WITH TENDER | RAHUL GANGULY      | HARISH KUMAR   | HARISH KUMAR                         |                     |
| B              | 14-JUL-2021                                                                                                                                        | ISSUED WITH MR               | 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                     | Job No.            | B269         | Unit No.                             | 999 |
|          | Wave shape of impulse voitage                                                           |                              |                    |              |                                      |     |
| 21.      | 1 sec. short ckt. Withstand capacity                                                    | kA                           |                    |              |                                      |     |
| 22.      | Peak dynamic withsatnd capacity                                                         | kA                           |                    |              |                                      |     |
| 23.      | Safety Features                                                                         |                              |                    |              |                                      |     |
|          | (a).Heat shrinkable sleeves, rated to                                                   |                              |                    |              |                                      |     |
|          | withstand the system line to line                                                       |                              |                    |              |                                      |     |
|          | voltage for one min., provided on busbar                                                |                              |                    |              |                                      |     |
|          | (b).Removable FRP shrouds for all busbar                                                |                              |                    |              |                                      |     |
|          | joints and tap-off connections provided                                                 |                              |                    |              |                                      |     |
|          | (c).Arc propagation barrier in busbar                                                   |                              |                    |              |                                      |     |
|          | compartment provided                                                                    |                              |                    |              |                                      |     |
|          | (d).Breaker service, test and drawn-                                                    |                              |                    |              |                                      |     |
|          | out position provided                                                                   |                              |                    |              |                                      |     |
|          | (e).Distinct overall lockable door for                                                  |                              |                    |              |                                      |     |
|          | breaker compartment provided                                                            |                              |                    |              |                                      |     |
|          | (f).Automatic safety shutter provided                                                   |                              |                    |              |                                      |     |
|          | (g).Independent pressure release                                                        |                              |                    |              |                                      |     |
|          | flaps provided for all HV compartments                                                  |                              |                    |              |                                      |     |
|          | (h).Wire mesh for all louvered                                                          |                              |                    |              |                                      |     |
|          | openings provided                                                                       |                              |                    |              |                                      |     |
|          | (i).Suitable intrlocks to prevent                                                       |                              |                    |              |                                      |     |
|          | faulty operation as per Cl. 4.4.10                                                      |                              |                    |              |                                      |     |
|          | of spec. 6-51-0001 provided                                                             |                              |                    |              |                                      |     |
|          | B. Circuit Breaker                                                                      |                              |                    |              |                                      |     |
| 1.       | Type                                                                                    |                              |                    |              |                                      |     |
|          | 2nd shunt trip coil for VFD feeders                                                     |                              |                    |              |                                      |     |
| 2.       | Make                                                                                    |                              |                    |              |                                      |     |
| 3.       | Type Designation                                                                        |                              |                    |              |                                      |     |
| 4.       | Circuit Breaker mounting in panel                                                       |                              |                    |              |                                      |     |
| 5.       | No. of poles/phase                                                                      |                              |                    |              |                                      |     |
| 6.       | Current rating (in free air)                                                            | A                            |                    |              |                                      |     |
| 7.       | Current rating inside the panel at specified design tempeature                          | A                            |                    |              |                                      |     |
| 8.       | Short time rating ( 1sec.)                                                              | kA                           |                    |              |                                      |     |
| 9.       | Symmetrical breaking capapcity                                                          | kA                           |                    |              |                                      |     |
| 9.1      | % D.C. Component                                                                        |                              |                    |              |                                      |     |
| 10.      | Peak making current                                                                     | kA                           |                    |              |                                      |     |
| 11.      | 1 min. dry withsatnd voltage (power frequency)                                          | kV                           |                    |              |                                      |     |
| 12.      | Duty Cycle                                                                              |                              |                    |              |                                      |     |
| 13.      | Total openeing time                                                                     | m sec.                       |                    |              |                                      |     |
| 14.      | Total closing time                                                                      | m sec.                       |                    |              |                                      |     |
| 15.      | Power required for opening                                                              | W/VA                         |                    |              |                                      |     |
| 16.      | Power required for closing                                                              | W/VA                         |                    |              |                                      |     |
| 17.      | Power required for spring charging motor                                                | W/VA                         |                    |              |                                      |     |
| 18.      | Breaker is trip free                                                                    |                              |                    |              |                                      |     |
| 19.      | Closing mechanism                                                                       |                              |                    |              |                                      |     |
| 20.      | Provision of manual spring charging provided                                            |                              |                    |              |                                      |     |
| 21.      | Mechanical Trip PB provided                                                             |                              |                    |              |                                      |     |
|          |                                                                                         |                              |                    |              |                                      |     |
|          |                                                                                         |                              |                    |              |                                      |     |
| C        | 06-APR-2022                                                                             | REVISED & ISSUED WITH TENDER | RAHUL GANGULY      | HARISH KUMAR | HARISH KUMAR                         |     |
| B        | 14-JUL-2021                                                                             | ISSUED WITH MR               | 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> |  | <b>Job No.</b>  | B269                                 |
|                |                                                                                         |                 |  | <b>Unit No.</b> | 999                                  |
| 22.            | Mech. On/Off indicator provided                                                         |                 |  |                 |                                      |
| 23.            | Operation counter provided                                                              |                 |  |                 |                                      |
| 24.            | Time taken for spring charging                                                          | sec.            |  |                 |                                      |
| 25.            | No. of aux. contacts and their current ratings                                          |                 |  |                 |                                      |
| 26.            | Interrupter                                                                             |                 |  |                 |                                      |
|                | (a).Make                                                                                |                 |  |                 |                                      |
|                | (b).Pressure switch for monitoring of SF6 gas pressure provided                         |                 |  |                 |                                      |
|                | (c).Re-filling arrangement of SF6                                                       |                 |  |                 |                                      |
| 27.            | LOTO (Lock-Out Tag-Out) Provision for mechanical locking arrangement                    |                 |  |                 |                                      |
| 28.            | Suppressor                                                                              |                 |  |                 |                                      |
|                | Type designation                                                                        |                 |  |                 |                                      |
|                | Make                                                                                    |                 |  |                 |                                      |
| 27.            | Derating reqd. for Cap. Switching                                                       |                 |  |                 |                                      |
| 29.            | Earthing System                                                                         |                 |  |                 |                                      |
| 30.            | Copies of following test certificates enclosed                                          |                 |  |                 |                                      |
|                | For each type of offered circuit breaker panel with breake                              |                 |  |                 |                                      |
|                | (a).Short Circuit tests (Peak and 1 sec.withstand)                                      |                 |  |                 |                                      |
|                | (b).Heat run test                                                                       |                 |  |                 |                                      |
|                | (c).Internal arc test                                                                   |                 |  |                 |                                      |
|                | (d).Impulse and power freq. withstand                                                   |                 |  |                 |                                      |
|                | For each type of offered circuit breaker (in panel)                                     |                 |  |                 |                                      |
|                | (a).Short Circuit test duties                                                           |                 |  |                 |                                      |

#### Eil Notes

- Internal Arc classification for HV switchboards shall be 40kA for 0.2sec.
- Variation/ Clarification against the standard specification for HV switchboards 6-51-0001, shall be as per the MoU agreed with EIL by respective HV switchboard manufacturer. No further deviations to tender requirements shall be entertained.

|          |             |                              |                    |              |              |
|----------|-------------|------------------------------|--------------------|--------------|--------------|
| C        | 06-APR-2022 | REVISED & ISSUED WITH TENDER | RAHUL GANGULY      | HARISH KUMAR | HARISH KUMAR |
| B        | 14-JUL-2021 | ISSUED WITH MR               | 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  |



## 6.6 kV HV SWITCHGEAR FEEDER DETAIL DATA SHEET (HV-100201)

Data sheet No.

**B269-999-16-50-DS-0075**
**Rev. No. A**

|      |            |                                    |          |         |          |
|------|------------|------------------------------------|----------|---------|----------|
|      |            |                                    |          |         |          |
| A    | 01.04.2022 | ISSUED WITH TECHNICAL AMENDMENT-01 | MKM      | RG      | HK       |
| Rev. | Date       |                                    | Prepared | Checked | Approved |

|                  |           |                    |                    |                   |                    |
|------------------|-----------|--------------------|--------------------|-------------------|--------------------|
| Project          | P-25      | Unit               | MRSS+ETP+RODM+RWTP | Client            | M/s IOCL - PANIPAT |
| Switchgear No.   | HV-100201 | Location           | MRSS # 100         | Fast Bus Transfer | Required           |
| Voltage          | 6.6 kV    | Curent             | 2500Amps           | Fault Level       | 40 kA (1 Sec)      |
| Bus Differential | Required  | Bus Diff. CT Ratio | 2500 /1            | IAC               | 40 kA (0.2 Sec)    |

| S.No. | Feeder Nameplate Inscription |              |                                                    |              | Bus Section |     |       | Breaker Rating/<br>Feeder<br>Designation | CT Primary Rating (A)* |                         |                                  |                   | Cable Details # |      |      | Reference                 |                       | Remarks                |
|-------|------------------------------|--------------|----------------------------------------------------|--------------|-------------|-----|-------|------------------------------------------|------------------------|-------------------------|----------------------------------|-------------------|-----------------|------|------|---------------------------|-----------------------|------------------------|
|       | Panel No. @                  | Feeder No. # | Feeder Description                                 | Rating (kW)# | Left        | Mid | Right |                                          | Metering               | Protection              |                                  |                   | Run             | Core | Size | EIL Hardware<br>Datasheet | Vendor<br>Scheme No.@ |                        |
|       |                              |              |                                                    |              |             |     |       |                                          |                        | O/C,S/C,<br>E/F & Motor | Feeder/<br>Motor<br>Differential | REF<br>Protection |                 |      |      |                           |                       |                        |
| 1     |                              |              | Incomer from<br>TR-100031 (20/25 MVA Power Trafo.) |              | 1           |     |       | 2500A                                    | 2500                   | 2500                    | 2500                             | 2500              | -               | -    | -    | DS-0003                   |                       | Bus Duct<br>Connection |
| 2     |                              |              | Incomer from<br>TR-100032 (20/25 MVA Power Trafo.) |              |             |     | 1     | 2500A                                    | 2500                   | 2500                    | 2500                             | 2500              | -               | -    | -    | DS-0003                   |                       | Bus Duct<br>Connection |
| 3     |                              |              | Line PT - Incomer 1                                |              | 1           |     |       | -                                        | -                      | -                       | -                                | -                 | -               | -    | -    | DS-0003                   |                       |                        |
| 4     |                              |              | Line PT - Incomer 2                                |              |             |     | 1     | -                                        | -                      | -                       | -                                | -                 | -               | -    | -    | DS-0003                   |                       |                        |
| 5     |                              |              | Bus PT - Bus 1                                     |              | 1           |     |       | -                                        | -                      | -                       | -                                | -                 | -               | -    | -    | DS-0011                   |                       |                        |
| 6     |                              |              | Bus PT - Bus 2                                     |              |             |     | 1     | -                                        | -                      | -                       | -                                | -                 | -               | -    | -    | DS-0011                   |                       |                        |
| 7     |                              |              | Bus Coupler - 1                                    |              |             | 1   |       | 2500A                                    | 2500                   | 2500                    | -                                | -                 | -               | -    | -    | DS-0005                   |                       |                        |
| 8     |                              |              | Bus Coupler - 2                                    |              |             | 1   |       | 2500A                                    | 2500                   | 2500                    | -                                | -                 | -               | -    | -    | DS-0016                   |                       |                        |
| 9     |                              |              | Capacitor Feeder - 1                               |              | 1           |     |       | 800A                                     | 300                    | 300                     | -                                | -                 | \$              | \$   | \$   | DS-0008                   |                       |                        |
| 10    |                              |              | Capacitor Feeder - 2                               |              |             |     | 1     | 800A                                     | 300                    | 300                     | -                                | -                 | \$              | \$   | \$   | DS-0008                   |                       |                        |
| 11    |                              |              | Transformer Feeder<br>TR-100041 (min. 2.5 MVA)     |              | 1           |     |       | 800A                                     | 300                    | 300                     | -                                | -                 | \$              | \$   | \$   | DS-0006                   |                       |                        |
| 12    |                              |              | Transformer Feeder<br>TR-100042 (min. 2.5 MVA)     |              |             |     | 1     | 800A                                     | 300                    | 300                     | -                                | -                 | \$              | \$   | \$   | DS-0006                   |                       |                        |
|       |                              |              | Transformer Feeder<br>TR-100043 (min. 2.5 MVA)     |              |             |     | 1     | 800A                                     | 300                    | 300                     | -                                | -                 | \$              | \$   | \$   | DS-0006                   |                       |                        |
| 13    |                              |              | Spare Transformer Feeder<br>(min. 2.5 MVA)         |              | 1           |     | 1     | 800A                                     | 300                    | 300                     | -                                | -                 | \$              | \$   | \$   | DS-0006                   |                       |                        |
| 16    | Format No: EIL 165           | 1401         | Plant Feeder to HV-122201 I/C-1                    |              | 1           |     |       | 800A                                     | 300                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   | All rights reserved   | All rights reserved    |

Format No: EIL 1650-3001A Rev. 2

Page 1 of 2

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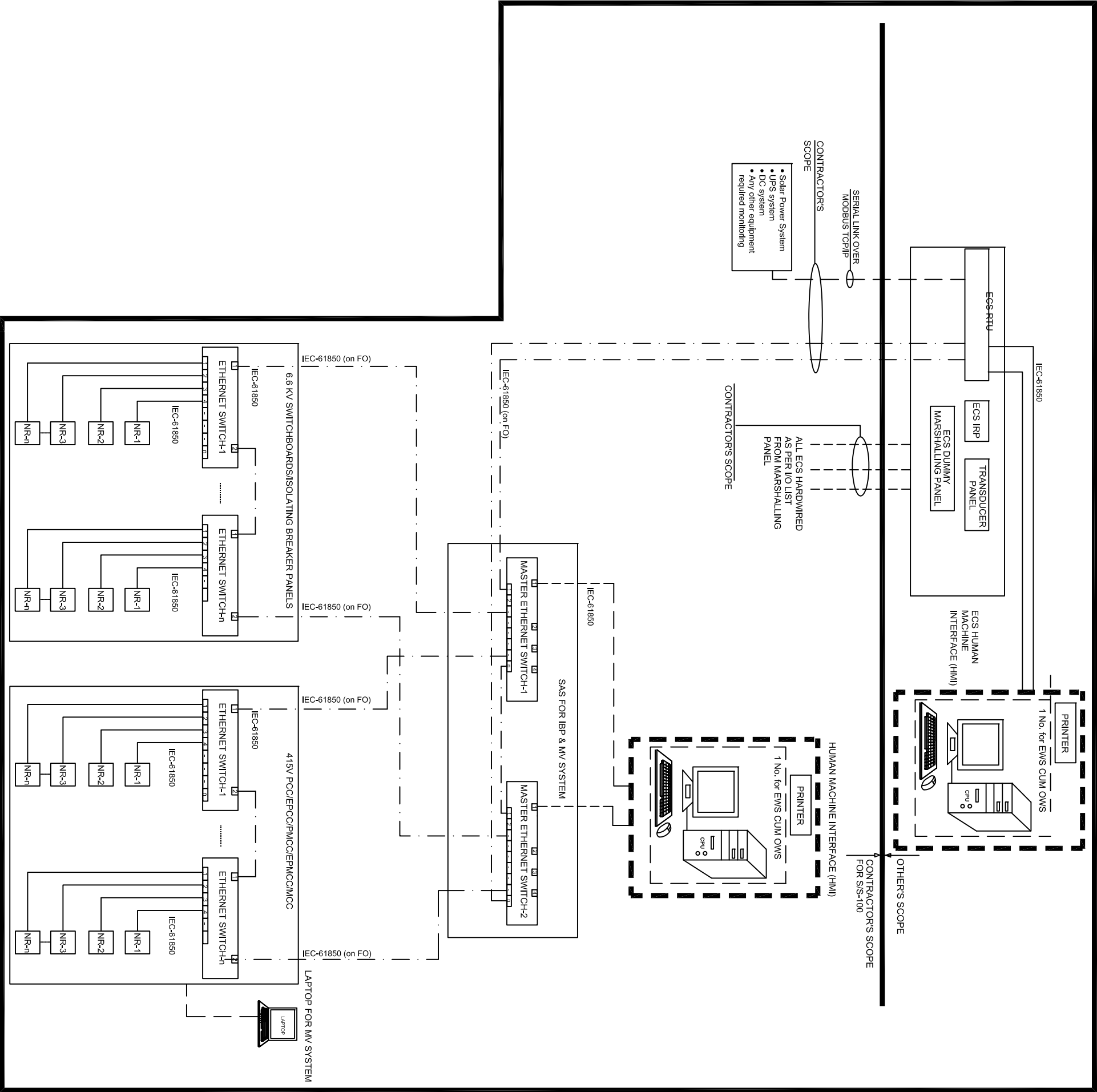
| S.No. | Feeder Nameplate Inscription |              |                                 |              | Bus Section |     |       | Breaker Rating/<br>Feeder<br>Designation | CT Primary Rating (A)* |                         |                                  |                   | Cable Details # |      |      | Reference                 |                       | Remarks                        |
|-------|------------------------------|--------------|---------------------------------|--------------|-------------|-----|-------|------------------------------------------|------------------------|-------------------------|----------------------------------|-------------------|-----------------|------|------|---------------------------|-----------------------|--------------------------------|
|       | Panel No. @                  | Feeder No. # | Feeder Description              | Rating (kW)# | Left        | Mid | Right |                                          | Metering               | Protection              |                                  |                   | Run             | Core | Size | EIL Hardware<br>Datasheet | Vendor<br>Scheme No.@ |                                |
|       |                              |              |                                 |              |             |     |       |                                          |                        | O/C,S/C,<br>E/F & Motor | Feeder/<br>Motor<br>Differential | REF<br>Protection |                 |      |      |                           |                       |                                |
| 17    |                              |              | Plant Feeder to HV-122201 I/C-2 |              |             |     | 1     | 800A                                     | 800                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   |                       | Feeders to be used<br>by Owner |
| 18    |                              |              | Plant Feeder to HV-112201 I/C-1 |              | 1           |     |       | 800A                                     | 800                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   |                       |                                |
| 19    |                              |              | Plant Feeder to HV-112201 I/C-2 |              |             |     | 1     | 800A                                     | 800                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   |                       |                                |
| 20    |                              |              | Plant Feeder to HV-109201 I/C-1 |              | 1           |     |       | 800A                                     | 800                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   |                       |                                |
| 21    |                              |              | Plant Feeder to HV-109201 I/C-2 |              |             |     | 1     | 800A                                     | 800                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   |                       |                                |
| 22    |                              |              | Spare Plant Feeder              |              | 1           |     | 1     | 800A                                     | 800                    | 800                     | 800                              |                   | 2               | 3    | 300  | DS-0028                   |                       |                                |
| 23    |                              |              | Dummy Panel                     |              |             |     |       |                                          |                        |                         |                                  |                   |                 |      |      |                           |                       | As required                    |

**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 Contractor.
4. Cable sizes are indicative and actual cable size shall be informed during review of documents.
5. Dummy panel with flexibles shall be provided for switchboards located in substations having expansion joints in the building.
6. Any additional 6.6kV feeders required for feeding 220kV GIS package loads shall be provided by Contractor without any time and cost implications.

NOTES

1. System architecture defines basic requirement of numerical relays integration with HMI & Electrical Control System (ECS) as a part of substation automation. Detailed architecture shall be developed by Contractor or their selected manufacturer.
2. System shall be engineered such that any board can be taken out for maintenance or removed without affecting communication with other boards.
3. Protocol shall be IEC 61850-RSTP providing all functionalities such as protection, control, relay parameterization, time synchronization, down loading disturbance record etc. Protocol for communication to ECS-RTU shall IEC 61850.
4. Scope split between Owner and Contractor, refer Job Specification attached with bid document. Interface cabling between ECS-RTU and ECS I/F panels shall be done by Owner/ Other Contractor.
5. LAPTOP along with programming and application software shall be supplied as required with license.
6. The supplied architecture should, in addition to this architecture, meet the requirement of numerical relay data sheet, Job Specification and EIL Specification 6-51-0055 attached with the bid document.
7. The communication protocol between Numerical relay and Ethernet Switches shall be IEC-61850.
8. The communication protocol between Ethernet switches and ECS RTU panel shall be IEC-61850.
9. CONTRACTOR shall furnish detailed system architecture drawing giving explicit details of protocol, redundancy and topology in line with Tender requirements.
10. Human Machine Interface-HMI/ shall communicate with Ethernet switches over IEC-61850 Protocol.
11. Refer clause no. 6.1.2 & Figure No.-02 of attached specification for Numerical relay & Substation Automation System Doc. No. (6-51-0055) for system configuration details.
12. ICD files shall be provided for IEDs (relays etc.)/ any other device as required by vendor as the same shall be required by ECS vendor for configuration purpose during detailed engineering.
13. GPS and antenna shall be provided in each substation for time synchronization as per Tender requirement



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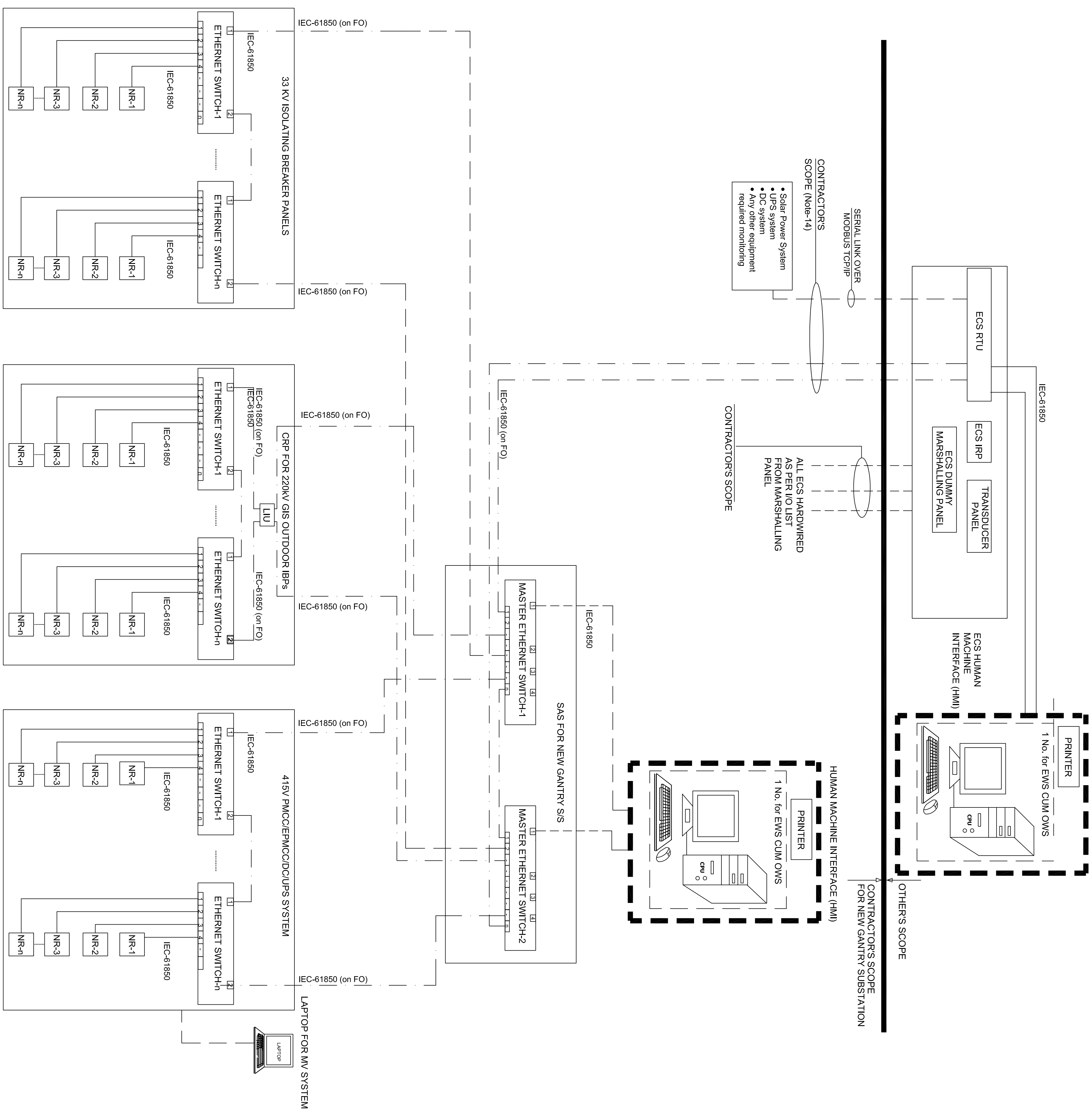
PROJECT : PANIPAT REFINERY  
EXPANSION (P-25)  
CLIENT : M/s IOCL-PANIPAT

| REV. | DATE       | ISSUED WITH TENDER               | BY  | CHK | APPROVED |
|------|------------|----------------------------------|-----|-----|----------|
| A    | 12.05.2020 | ISSUED WITH TENDER               | AKG | HK  | HK       |
| B    | 05.07.2021 | REVISED AND REISSUED WITH TENDER | AKG | HK  | HK       |
| C    | 11.04.2022 | REVISED AND REISSUED WITH TENDER | RG  | HK  | HK       |

BLOCK DIAGRAM FOR  
NUMERICAL RELAY LAN & SUBSTATION  
AUTOMATION SYSTEM  
HV IBPs & MV SWITCHBOARDS  
(MRSS-100)

| DRAWING NO.            | REV. |
|------------------------|------|
| B269-999-16-50-DS-0130 | C    |





- ## NOTES
1. System architecture defines basic requirement of numerical relays integration with HMI & Electrical Control System (ECS) as a part of substation automation. Detailed architecture shall be developed by Contractor or their selected manufacturer.
  2. System shall be engineered such that any board can be taken out for maintenance or removed without affecting communication with other boards.
  3. Protocol shall be IEC 61850-RSTP providing all functionalities such as protection, control, relay parameterization, time synchronization, down loading disturbance record etc. Protocol for communication to ECS-RTU shall IEC 61850.
  4. Scope split between Owner and Contractor, refer Job Specification attached with bid document. Interface cabling between ECS-RTU and ECS I/F panels shall be done by Owner/ Other Contractor.
  5. LAPTOP along with programming and application software shall be supplied as required with license.
  6. The supplied architecture should, in addition to this architecture, meet the requirement of numerical relay data sheet, Job Specification and EIL Specification 6-51-0055 attached with the bid document.
  7. The communication protocol between Numerical relay and Ethernet Switches shall be IEC-61850.
  8. The communication protocol between Ethernet switches and ECS RTU panel shall be IEC-61850.
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  10. Human Machine Interface-HMI/ shall communicate with Ethernet switches over IEC-61850 Protocol.
  11. Refer clause no. 6.1.2 & Figure No.-02 of attached specification for Numerical relay & Substation Automation System Doc. No. (6-51-0055) for system configuration details.
  12. ICD files shall be provided for IEDs (relays etc.) any other device as required by vendor as the same shall be required by ECS vendor for configuration purpose during detailed engineering.
  13. GPS and antenna shall be provided in each substation for time synchronization as per Tender requirement.
  14. Supply and termination of FO cables & HDPE Duct between New Gantry S/S to ECS Panel in MRSS-100 shall be done by Contractor. Laying of this FO cable by other.

|  |                                                                                         | <b>HV CAPACITOR BANK DATA SHEET</b> |                    | <b>Document No.</b><br>B269-999-16-50-DS-0150<br><b>Rev. No.</b> A<br>Page 1 of 3 |                     |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------|--------------------|-----------------------------------------------------------------------------------|---------------------|
| <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>                     | <b>Job No.</b>     | B269                                                                              | <b>Unit No.</b> 999 |
| <b>PURCHASER'S DATA</b>                                                          |                                                                                         |                                     |                    |                                                                                   |                     |
| <b>A. Site Conditions</b>                                                        |                                                                                         |                                     |                    |                                                                                   |                     |
| 1.                                                                               | Maximum Ambient Temperature                                                             | °C                                  | 50                 |                                                                                   |                     |
| 2.                                                                               | Minimum Ambient Temperature                                                             | °C                                  | 5                  |                                                                                   |                     |
| 3.                                                                               | Design Ambient Temperature                                                              | °C                                  | 45                 |                                                                                   |                     |
| 4.                                                                               | Relative Humidity                                                                       | %                                   | 90                 |                                                                                   |                     |
| 5.                                                                               | Altitude Above MSL                                                                      | mm                                  | 1000               |                                                                                   |                     |
| 6.                                                                               | Environment                                                                             | Hot, Humid & Corrosive              |                    |                                                                                   |                     |
| <b>B. Technical particulars</b>                                                  |                                                                                         |                                     |                    |                                                                                   |                     |
| 1.                                                                               | System nominal voltage                                                                  | kV                                  | 6.6 ± 10 %         |                                                                                   |                     |
| 2.                                                                               | Frequency                                                                               | Hz                                  | 50 ± 3 %           |                                                                                   |                     |
| 3.                                                                               | System earthing                                                                         | Resistance Earthed                  |                    |                                                                                   |                     |
| 4.                                                                               | Fault level                                                                             | kA                                  | 40                 |                                                                                   |                     |
| 5.                                                                               | No. of phases                                                                           | Three                               |                    |                                                                                   |                     |
| 6.                                                                               | Power frequency withstand                                                               |                                     |                    |                                                                                   |                     |
|                                                                                  | Capacitor bank                                                                          | kV                                  | 28                 |                                                                                   |                     |
|                                                                                  | Series reactor                                                                          | kV                                  |                    |                                                                                   |                     |
|                                                                                  | RVT                                                                                     | kV                                  |                    |                                                                                   |                     |
| 7.                                                                               | Impulse withstand voltage                                                               |                                     |                    |                                                                                   |                     |
|                                                                                  | Capacitor bank                                                                          | kVp                                 | 75                 |                                                                                   |                     |
|                                                                                  | Series reactor                                                                          | kVp                                 |                    |                                                                                   |                     |
|                                                                                  | RVT                                                                                     | kVp                                 |                    |                                                                                   |                     |
| 8.                                                                               | Minimum clearance Ph-Ph                                                                 | mm                                  | 229                |                                                                                   |                     |
| 9.                                                                               | Minimum clearance Ph-E                                                                  | mm                                  | 178                |                                                                                   |                     |
| 10.                                                                              | <b>Capacitor bank</b>                                                                   |                                     |                    |                                                                                   |                     |
| a.                                                                               | Rating at rated voltage at rated frequency                                              | Refer Job Specification             |                    |                                                                                   |                     |
| b.                                                                               | Nameplate nominal voltage                                                               |                                     |                    |                                                                                   |                     |
| c.                                                                               | Location                                                                                | Indoor Panel Mounted                |                    |                                                                                   |                     |
| d.                                                                               | Incoming isolator                                                                       |                                     |                    |                                                                                   |                     |
| e.                                                                               | Lightning arrester                                                                      |                                     |                    |                                                                                   |                     |
| f.                                                                               | Compensation for kVAR loss due to series reactor included                               | Yes                                 |                    |                                                                                   |                     |
| 11.                                                                              | <b>Capacitor unit</b>                                                                   |                                     |                    |                                                                                   |                     |
| a.                                                                               | Rating                                                                                  |                                     |                    |                                                                                   |                     |
| b.                                                                               | Nameplate Nominal voltage                                                               |                                     |                    |                                                                                   |                     |
| c.                                                                               | Power frequency/ Impulse voltage                                                        |                                     |                    |                                                                                   |                     |
| 12.                                                                              | <b>Series reactor</b>                                                                   |                                     |                    |                                                                                   |                     |
| a.                                                                               | Connected Load                                                                          | Capacitor Bank                      |                    |                                                                                   |                     |
| b.                                                                               | Percentage reactance                                                                    | %                                   | 6                  |                                                                                   |                     |
| c.                                                                               | Location                                                                                | Indoor Panel Mounted                |                    |                                                                                   |                     |
| d.                                                                               | Incoming cable                                                                          |                                     |                    |                                                                                   |                     |
| 13.                                                                              | <b>Residual voltage transformer</b>                                                     |                                     |                    |                                                                                   |                     |
| a.                                                                               | Primary voltage                                                                         | kV                                  | 6.6/v3             |                                                                                   |                     |
| b.                                                                               | Secondary voltage                                                                       | V                                   | 110/V3 & 110/V3    |                                                                                   |                     |
| c.                                                                               | Connection :                                                                            | Primary                             | Star               |                                                                                   |                     |
|                                                                                  |                                                                                         | Secondary                           | Star & Open Delta  |                                                                                   |                     |
|                                                                                  |                                                                                         |                                     |                    |                                                                                   |                     |
|                                                                                  |                                                                                         |                                     |                    |                                                                                   |                     |
|                                                                                  |                                                                                         |                                     |                    |                                                                                   |                     |
| A                                                                                | 12-MAY-2020                                                                             | ISSUED WITH MR/TENDER               | JAYENDRA L CHAUHAN | HARISH KUMAR                                                                      | HARISH KUMAR        |
| Rev. No.                                                                         | Date                                                                                    | Purpose                             | Prepared By        | Reviewed By                                                                       | Approved By         |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------|----------------------------------------------------|-----------------------------------------------------------------------------------|--------------|--|--|--|--|--|--|--|--|--|--|--|--|---|-------------|-----------------------|--------------------|--------------|--------------|----------|------|---------|-------------|-------------|-------------|
|                                                                                                                                                                                                                                                                                                                                                                        |                                              | <b>HV CAPACITOR BANK DATA SHEET</b> |                                                    | <b>Document No.</b><br>B269-999-16-50-DS-0150<br><b>Rev. No.</b> A<br>Page 2 of 3 |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| <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>                     |                                                    | <b>Job No.</b> B269 <b>Unit No.</b> 999                                           |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| d.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Rated output                                 |                                     | VA                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| e.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Accuracy class                               |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| f.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Location                                     |                                     | Indoor Panel Mounted                               |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| <b>A. Capacitor bank MANUFACTURER'S DATA</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Make                                         |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Applicable Standard                          |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Output                                       | Rated                               | kVAR                                               |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | maximum                             | kVAR                                               |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Voltage                                      | Rated                               | kV                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | maximum                             | kV                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Frequency                                    | Rated                               | Hz                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | maximum                             | Hz                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Inrush current                               | Initial                             | kA                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | Back to back                        | kA                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 7.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Temperature rise (Max.)                      |                                     | °C                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 8.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Type of connection                           |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 9.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | No. of capacitor units per bank              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 10.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | No. of capacitor units in parallel per phase |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 11.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Power Frequency Withstand Voltage            |                                     | kV RMS                                             |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 12.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1.2/ 50 microsec impulse volt withstand      |                                     | kV peak                                            |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 13.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Minimum clearance Ph-Ph                      |                                     | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 14.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Minimum clearance Ph-E                       |                                     | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 15.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Dimension                                    | Length                              | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | Breadth                             | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | Height                              | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 16.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Weight                                       |                                     | kg                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| <b>B. Capacitor units</b>                                                                                                                                                                                                                                                                                                                                                                                                                              |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Rated output voltage                         |                                     | kV                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Type of foil material                        |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Type of impregnant                           |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Dielectric strength of impregnant            |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Residual voltage                             |                                     | V                                                  |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Discharge time                               |                                     | sec                                                |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 7.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Dielectric losses                            |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 8.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Tangent of dielectric loss angle             |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 9.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Power Frequency Withstand Voltage            |                                     | kV RMS                                             |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 10.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1.2/ 50 microsec impulse volt withstand      |                                     | kV peak                                            |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 11.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Dimension                                    | Length                              | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | Breadth                             | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              | Height                              | mm                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 12.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Weight                                       |                                     | kg                                                 |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| <b>C. Series reactor</b>                                                                                                                                                                                                                                                                                                                                                                                                                               |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Make                                         |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Type of core                                 |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Type of cooling                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| <table border="1"> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>A</td> <td>12-MAY-2020</td> <td>ISSUED WITH MR/TENDER</td> <td>JAYENDRA L CHAUHAN</td> <td>HARISH KUMAR</td> <td>HARISH KUMAR</td> </tr> <tr> <td>Rev. No.</td> <td>Date</td> <td>Purpose</td> <td>Prepared By</td> <td>Reviewed By</td> <td>Approved By</td> </tr> </table> |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  | A | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | HARISH KUMAR | HARISH KUMAR | Rev. No. | Date | Purpose | Prepared By | Reviewed By | Approved By |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |                                     |                                                    |                                                                                   |              |  |  |  |  |  |  |  |  |  |  |  |  |   |             |                       |                    |              |              |          |      |         |             |             |             |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 12-MAY-2020                                  | ISSUED WITH MR/TENDER               | JAYENDRA L CHAUHAN                                 | 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>                                                                                            | <b>COMMON</b>                           | <b>Location</b> | <b>Job No.</b> B269                                | <b>Unit No.</b> 999 |  |
| 4.                                                                                                     | Rating                                  | kVA             |                                                    |                     |  |
| 5.                                                                                                     | Rated voltage                           | kV              |                                                    |                     |  |
| 6.                                                                                                     | Rated frequency                         | Hz              |                                                    |                     |  |
| 7.                                                                                                     | Current                                 | Rated           | A                                                  |                     |  |
|                                                                                                        |                                         | Maximum         | A                                                  |                     |  |
| 8.                                                                                                     | Resistance per phase                    | ohms            |                                                    |                     |  |
| 9.                                                                                                     | Reactance per phase                     | ohms            |                                                    |                     |  |
| 10.                                                                                                    | Reactive drop per phase                 | V               |                                                    |                     |  |
| 11.                                                                                                    | Rated load loss at 75°C                 | W               |                                                    |                     |  |
| 12.                                                                                                    | Temperature rise winding                | °C              |                                                    |                     |  |
| 13.                                                                                                    | Power Frequency Withstand Voltage       | kV RMS          |                                                    |                     |  |
| 14.                                                                                                    | 1.2/ 50 microsec impulse volt withstand | kV peak         |                                                    |                     |  |
| 15.                                                                                                    | Short time symmetrical current          | A               |                                                    |                     |  |
|                                                                                                        |                                         | Duration        | sec                                                |                     |  |
| 16.                                                                                                    | Resonance frequency                     | Hz              |                                                    |                     |  |
| 17.                                                                                                    | Dimension                               | Length          | mm                                                 |                     |  |
|                                                                                                        |                                         | Breadth         | mm                                                 |                     |  |
|                                                                                                        |                                         | Height          | mm                                                 |                     |  |
| 18.                                                                                                    | Weight                                  | kg              |                                                    |                     |  |
| <b>D. Residual voltage transformer</b>                                                                 |                                         |                 |                                                    |                     |  |
| 1.                                                                                                     | Make                                    |                 |                                                    |                     |  |
| 2.                                                                                                     | Primary Voltage                         |                 |                                                    |                     |  |
| 3.                                                                                                     | Secondary Voltage                       |                 |                                                    |                     |  |
| 4.                                                                                                     | Connection                              |                 |                                                    |                     |  |
| 5.                                                                                                     | Rated output & Accuracy class           |                 |                                                    |                     |  |
| 6.                                                                                                     | Residual voltage                        | V               |                                                    |                     |  |
| 7.                                                                                                     | Power Frequency Withstand Voltage       | kV RMS          |                                                    |                     |  |
| 8.                                                                                                     | 1.2/ 50 microsec impulse volt withstand | kV peak         |                                                    |                     |  |
| 9.                                                                                                     | Dimension                               | Length          | mm                                                 |                     |  |
|                                                                                                        |                                         | Breadth         | mm                                                 |                     |  |
|                                                                                                        |                                         | Height          | mm                                                 |                     |  |
| 10.                                                                                                    | Weight                                  | kg              |                                                    |                     |  |

#### Eil Notes

- 1 The Connection for RVT shall be Primary Star/ Secondary Star/Secondary Open Delta
- 2 Each Step shall be provided with separate RVT.

|          |             |                       |                    |              |              |
|----------|-------------|-----------------------|--------------------|--------------|--------------|
|          |             |                       |                    |              |              |
|          |             |                       |                    |              |              |
|          |             |                       |                    |              |              |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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** **Job No.** B269 **Unit No.** 999

**PURCHASER'S DATA**

|                                                    |                          |
|----------------------------------------------------|--------------------------|
| <b>A. Site Conditions</b>                          |                          |
| 1. Maximum Ambient Temperature                     | °C 50                    |
| 2. Minimum Ambient Temperature                     | °C 5                     |
| 3. Design Ambient Temperature                      | °C 45                    |
| 4. Relative Humidity                               | % 90                     |
| 5. Altitude Above MSL                              | mm 1000                  |
| 6. Environment                                     | Hot, Humid & Corrosive   |
| <b>B. Technical particulars</b>                    |                          |
| 1. System Voltage                                  |                          |
| Nominal                                            | 6.6KV(UE) / 33KV (E)     |
| Highest                                            | 7.2KV / 36KV             |
| Voltage grade                                      | 6.6/6.6KV, 19/33KV       |
| 2. Frequency                                       | Hz 50 +/- 3 %            |
| 3. Conductor material                              |                          |
| HV Power cable                                     | Aluminium / Copper       |
| MV Power cable                                     | NA                       |
| MV control cable                                   | NA                       |
| 4. Installation under DGMS jurisdiction (See Note) | No                       |
| 5. Applicable spec.                                | 6-51-0051                |
| 6. Insulation                                      | XLPE                     |
| 7. PVC compound type                               | ST-2                     |
| 8. Type of conductor                               | Stranded                 |
| 9. Conductor class                                 | As per Spec              |
| 10. Types of cable                                 | FRLS - Outersheathed     |
| 11. Armour                                         |                          |
| Type                                               | Refer EIL Spec 6-51-0051 |
| Size of armour                                     | As per 7098 (part-2)     |
| 12. Type of drum                                   | Steel                    |

**MANUFACTURER'S DATA**

|                                                 |    |
|-------------------------------------------------|----|
| <b>A. Technical particulars</b>                 |    |
| 1. Name of manufacturer                         |    |
| 2. MR/PR item no.                               |    |
| 3. Cable type/ code                             |    |
| 4. Conductor material                           |    |
| 5. Conductor semiconducting screen (HV cables)  |    |
| Material                                        |    |
| Thickness                                       | mm |
| 6. Insulation                                   |    |
| Type of compound                                |    |
| Thickness                                       | mm |
| 7. Insulation semiconducting screen (HV cables) |    |
| Material                                        |    |

|          |             |                |                   |              |              |
|----------|-------------|----------------|-------------------|--------------|--------------|
|          |             |                |                   |              |              |
|          |             |                |                   |              |              |
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| A        | 29-MAR-2022 | ISSUED WITH MR | VVSN MURTY VALLEM | MANISH 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> |  | <b>Job No.</b>  | B269                                 |
|                |                                                                                         |                 |  | <b>Unit No.</b> | 999                                  |

|     |                                             |      |  |
|-----|---------------------------------------------|------|--|
|     | Thickness                                   | mm   |  |
| 8.  | Copper tape                                 |      |  |
|     | Thickness                                   | mm   |  |
| 9.  | Inner sheath                                |      |  |
|     | Type of compound                            |      |  |
|     | Thickness                                   | mm   |  |
| 10. | Nominal dia under armour                    | mm   |  |
| 11. | Calculated dia under armour                 | mm   |  |
| 12. | Armour                                      |      |  |
|     | Material                                    |      |  |
|     | Type                                        |      |  |
|     | Size                                        |      |  |
| 13. | Nominal dia under outersheath               | mm   |  |
| 14. | Calculated dia under outersheath            | mm   |  |
| 15. | Outersheath                                 |      |  |
|     | Type of compound                            |      |  |
|     | Thickness                                   | mm   |  |
| 16. | Nominal outer dia of cable                  | mm   |  |
| 17. | Tolerance on outer dia                      | %    |  |
| 18. | Weight of cable per km                      | kg   |  |
| 19. | Maximum drum length                         | mtr. |  |
| 20. | Maximum DC resistance of conductor at 20 °C |      |  |
| 21. | AC resistance at 90 °C                      |      |  |
| 22. | Reactance of cable at 50 Hz                 |      |  |
| 23. | Capacitance of cable                        |      |  |
| 24. | Zero sequence impedance of cable            |      |  |
| 25. | Capacitive charging current per km          |      |  |

**Notes**

- E- Earthed system  
UE-Un Earthed system
- Single Line to Ground fault for sizing of Insulation screen for 6.6 kV cables shall be considered as 600 Amps (1 Second)
- Single Line to Ground fault for sizing of Insulation screen for 33 kV cables shall be considered as 40 kAmps (1 Second)
- Cables shall comply to EIL Standard Specification (Doc. No. 6-51-0051)
- Cables shall be dispatched in non-returnable Steel Drums.
- Vendor shall furnish the duly filled-in cable data sheet for each item separately.
- Vendor to provide and include following details for each cable type/size in cable data sheet:
  - nominal dia over armour
  - Current carrying capacity (in air at 40 deg C, in ground at 30 deg C, in duct at 30 deg C)
  - Short circuit current (KA) of conductor for 1 sec
  - Minimum bending radius
  - Embossing details as per EIL Specification 6-51-0051
- Vendor to provide following dimensions for each cable type/size: individual core dia. over insulation, individual core dia. Bare and dia. of individual core over shielding.

|          |             |                |                   |              |              |
|----------|-------------|----------------|-------------------|--------------|--------------|
|          |             |                |                   |              |              |
|          |             |                |                   |              |              |
|          |             |                |                   |              |              |
| A        | 29-MAR-2022 | ISSUED WITH MR | VVSN MURTY VALLEM | MANISH KUMAR | HARISH KUMAR |
| Rev. No. | Date        | Purpose        | Prepared By       | Reviewed By  | Approved By  |

| PURCHASER'S DATA               |                                         |            |    |                                                         |                       |
|--------------------------------|-----------------------------------------|------------|----|---------------------------------------------------------|-----------------------|
| <b>A Site conditions</b>       |                                         |            |    |                                                         |                       |
| 1                              | Maximum ambient temperature:            | 50 °C      | 4  | Relative humidity:                                      | 90 %                  |
| 2                              | Minimum ambient temperature:            | 5 °C       | 5  | Altitude                                                | < 1000 m              |
| 3                              | Design ambient temperature:             | 45 °C      | 6  | Environment:                                            | Humid & corrosive     |
| <b>B Technical particulars</b> |                                         |            |    |                                                         |                       |
| 1                              | System voltage                          |            | 5  | Rated earth fault current (Corrugated aluminium sheath) |                       |
|                                | Nominal Highest Voltage grade           |            |    | Current (66kV)                                          | 40 KA                 |
|                                | 66KV (E) 72.5KV 38/66KV                 |            |    | Duration                                                | 1 sec                 |
|                                | 110KV(E) 123KV 64/110KV                 |            |    |                                                         |                       |
|                                | 132KV(E) 145KV 76/132KV                 |            | 6  | Moisture Barrier                                        | Corrugated Aluminium  |
|                                | 220KV(E) 245KV 127/220KV                |            |    |                                                         |                       |
|                                | 400KV(E) 420KV 400/220KV                |            | 7  | Metallic screen bonding Link boxes                      | Yes/No                |
| 2                              | Frequency                               | 50Hz ± % 3 |    |                                                         |                       |
|                                |                                         |            | 8  | Sheath Voltage Limiter                                  | Required/Not-required |
| 3                              | Conductor material                      | Copper     | 9  | Type of termination kits                                | Heat Shrinkable       |
| 4                              | Rated system fault level                |            |    |                                                         |                       |
|                                | Current (66kV)                          | 40 KA      | 10 | Type of jointing kits                                   | Heat Shrinkable       |
|                                | Duration                                | 1 sec      |    |                                                         |                       |
|                                |                                         |            | 11 | Applicable spec.                                        | As per MR             |
| MANUFACTURER'S DATA            |                                         |            |    |                                                         |                       |
| <b>A Cable</b>                 |                                         |            |    |                                                         |                       |
| 1                              | Name of manufacturer                    |            | 11 | Inner sheath                                            |                       |
| 2                              | MR/PR Item no.                          |            |    | Type of compound                                        |                       |
| 3                              | Cable type/ code                        |            |    | Thickness                                               | mm                    |
| 4                              | Cross-section of conductor              |            | 12 | Nominal dia under armour                                | mm                    |
| 5                              | Conductor material                      |            | 13 | Calculated dia under armour                             | mm                    |
| 6                              | Conductor semiconducting screen         |            | 14 | Armour                                                  |                       |
|                                | Material                                |            |    | Material                                                |                       |
|                                | Thickness                               | mm         |    | Type                                                    |                       |
| 7                              | Insulation                              |            |    | Size                                                    |                       |
|                                | Type of compound                        |            | 15 | Nominal dia under outersheath                           | mm                    |
|                                | Thickness                               | mm         | 16 | Calculated dia under outersheath                        | mm                    |
| 8                              | Insulation screen                       |            | 17 | Outer sheath                                            |                       |
|                                | Non metallic                            |            |    | Type of compound                                        |                       |
|                                | Material                                |            |    | Thickness                                               | mm                    |
|                                | Thickness                               | mm         | 18 | Material of conductive coating over                     |                       |
|                                | Thickness of water swellable tape layer | mm         |    | outer sheath                                            |                       |
|                                | Metallic                                |            | 19 | Nominal outer dia of cable                              | mm                    |
|                                | Size & no. of copper wires              |            | 20 | Tolerance on outer dia                                  | %                     |
|                                | size & thickness of copper tape         | mm         | 21 | Weight of cable per mtr                                 | Kg                    |
|                                | Thickness of water swellable tape layer | mm         | 22 | Maximum drum length                                     | mtr.                  |
| 9                              | Moisture barrier                        |            | 23 | Bending radius                                          | mm                    |
|                                | Material                                |            | 24 | Recommended type of metallic screen/                    |                       |
|                                | Thickness                               | mm         |    | sheath bonding scheme                                   |                       |
| 10                             | Metallic Sheath                         |            | 25 | Current carrying capacity                               |                       |
|                                | Material                                |            |    | In air at 45°C                                          |                       |
|                                | Thickness                               | mm         |    | In ground at 35°C                                       |                       |
| <b>B Accessories</b>           |                                         |            |    |                                                         |                       |
| 1                              | Metallic screen bonding Link Boxes      |            | 3  | Termination kit                                         |                       |
|                                | Make                                    |            |    | Make                                                    |                       |
|                                | Material of construction                |            |    | Type                                                    |                       |
|                                | Degree of Ingress protection            |            | 4  | Jointing Kit                                            |                       |
| 2                              | Sheath Voltage Limiter                  |            |    | Make                                                    |                       |
|                                | Make                                    |            |    | Type                                                    |                       |
|                                | Type                                    |            |    |                                                         |                       |
|                                | Voltage                                 |            |    |                                                         |                       |

**Notes**

- 1 E - Earthed
- 2 Creepage distance for cable accessories shall be selected considering heavily polluted (31mm/KV) environment as per IEC

|          |          |                |             |            |             |
|----------|----------|----------------|-------------|------------|-------------|
| A        | 16.03.22 | ISSUED WITH MR | Rahul       | RS         | HK          |
| Rev. No. | Date     | Purpose        | Prepared by | Checked 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**

**Job No.** B269

**Unit No.** 999

**PURCHASER'S DATA**

|                                 |                             |     |                         |
|---------------------------------|-----------------------------|-----|-------------------------|
| <b>A. Site Conditions</b>       |                             |     |                         |
| 1.                              | Maximum Ambient Temperature | °C  | 50                      |
| 2.                              | Minimum Ambient Temperature | °C  | 5                       |
| 3.                              | Design Ambient Temperature  | °C  | 45                      |
| 4.                              | Relative Humidity           | %   | 90                      |
| 5.                              | Altitude Above MSL          | mm  | 1000                    |
| 6.                              | Environment                 |     | Hot, Humid & Corrosive  |
| <b>B. Technical particulars</b> |                             |     |                         |
| 1.                              | Tag no.:                    |     |                         |
| 2.                              | Duty:                       |     | Continuous              |
| 3.                              | No. of windings:            |     | Two                     |
| 4.                              | Type of cooling:            |     | ONAN/ONAF               |
| 5.                              | Rated MVA                   |     |                         |
| 6.                              | Oil type                    |     | Mineral (as per IS 335) |
| 7.                              | Rated voltage               |     |                         |
|                                 | HV winding                  | kV  | 66                      |
|                                 | LV-1 winding                | kV  | 6.9                     |
|                                 | LV-2 winding                | kV  | Not applicable          |
| 8.                              | HV Phase sequence           |     | UVW                     |
| 9.                              | LV Phase sequence           |     | To suit switchgear      |
| 10.                             | System earthing:            |     |                         |
|                                 | HV side                     |     | Solidly earthed         |
|                                 | LV side-1                   |     | Resistance earthed      |
|                                 | LV side-2                   |     | Not applicable          |
| 11.                             | Rated frequency:            | Hz  | 50 +/- 3 %              |
| 12.                             | No. of phases:              |     | Three                   |
| 13.                             | Fault level on HV side:     | kA  | 40                      |
| 14.                             | Connection                  |     |                         |
|                                 | HV side                     |     | Delta                   |
|                                 | LV side-1                   |     | Star                    |
|                                 | LV side-2                   |     | Not applicable          |
| 15.                             | Vector group:               |     | Dyn1                    |
| 16.                             | Impedance at max. MVA:      |     |                         |
|                                 | HV-LV1                      | %   | 8                       |
|                                 | HV-LV2                      | %   | Not applicable          |
| 17.                             | Insulation class:           |     | A                       |
| 18.                             | Insulation level            |     |                         |
|                                 | P.f withstand               |     |                         |
|                                 | HV winding                  | kV  | AS PER IS & CBIP        |
|                                 | LV-1 winding                | kV  | AS PER IS & CBIP        |
|                                 | LV-2 winding                | kV  | Not applicable          |
|                                 | Impulse withstand           |     |                         |
|                                 | HV winding                  | kVp | AS PER IS & CBIP        |
|                                 | LV-1 winding                | kVp | AS PER IS & CBIP        |
|                                 | LV-2 winding                | kVp | Not applicable          |

|          |             |                       |                    |              |              |
|----------|-------------|-----------------------|--------------------|--------------|--------------|
| D        | 08-APR-2022 | ISSUED WITH MR        | VVSN MURTY VALLEM  | HARISH KUMAR | HARISH KUMAR |
| C        | 01-APR-2022 | ISSUED WITH MR        | VVSN MURTY VALLEM  | MANISH KUMAR | HARISH KUMAR |
| B        | 20-NOV-2020 | ISSUED WITH MR/TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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**

**Job No.** B269

**Unit No.** 999

|     |                                                                |                              |
|-----|----------------------------------------------------------------|------------------------------|
| 19. | Winding insulation type:                                       |                              |
|     | HV winding                                                     | Uniform                      |
|     | LV winding-1                                                   | Uniform                      |
|     | LV winding-2                                                   | Not applicable               |
| 20. | Creepage distance                                              |                              |
|     | HV winding                                                     | 31 mm/kV                     |
|     | total                                                          | mm As per IS/CBIP            |
|     | protected                                                      | mm As per IS/CBIP            |
|     | LV-1 winding                                                   | 31 mm/kV                     |
|     | total                                                          | mm As per IS/CBIP            |
|     | protected                                                      | mm As per IS/CBIP            |
|     | LV-2 winding                                                   | NOT APPLICABLE               |
|     | total                                                          | mm Not applicable            |
| 21. | Continuous parallel operation                                  | NOT APPLICABLE               |
| 22. | Limiting dimension                                             | 12M X 12M Bay                |
| 23. | Noise level                                                    | AS PER IS & CBIP             |
| 24. | Clearance:                                                     |                              |
|     | Ph-Ph                                                          | mm AS PER IS & CBIP          |
|     | Ph-N                                                           | mm AS PER IS & CBIP          |
| 25. | Tap changer                                                    |                              |
|     | Location                                                       | HV winding                   |
|     | Type                                                           | OLTC                         |
|     | Range                                                          | % $\pm 10$                   |
|     | No. of steps                                                   | 17                           |
|     | RTCC Panel                                                     | Required                     |
|     | AVR                                                            | Required                     |
|     | Master-follower sys.                                           | Required                     |
|     | Bi Dir. Power flow                                             | Not Required                 |
|     | Local Remote operation                                         | Required                     |
| 26. | Normal load:                                                   | % 30-40                      |
| 27. | Temp. rise at extreme tap having max. losses :                 |                              |
|     | oil                                                            | °C 45                        |
|     | winding                                                        | °C 50                        |
| 28. | Minimum guaranteed efficiency at 0.8 p.f at 40% of ONAN rating | Minimum 99.5                 |
| 29. | Power flow:                                                    | Unidirectional               |
| 30. | Explosion protection                                           | PRV                          |
| 31. | Terminal location:                                             |                              |
|     | HV side                                                        | Larger side                  |
|     | LV w.r.t HV                                                    | ° 90                         |
| 32. | Terminal connection                                            |                              |
|     | HV side                                                        | Cable box                    |
|     | LV side                                                        | Busduct                      |
| 33. | Cable size                                                     |                              |
|     | HV side                                                        | 3R X 1C X 300mm <sup>2</sup> |
|     | LV-1 side                                                      | Not applicable               |
|     | LV-2 side                                                      | Not applicable               |

|          |             |                       |                    |              |              |
|----------|-------------|-----------------------|--------------------|--------------|--------------|
| D        | 08-APR-2022 | ISSUED WITH MR        | VVSN MURTY VALLEM  | HARISH KUMAR | HARISH KUMAR |
| C        | 01-APR-2022 | ISSUED WITH MR        | VVSN MURTY VALLEM  | MANISH KUMAR | HARISH KUMAR |
| B        | 20-NOV-2020 | ISSUED WITH MR/TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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>                        |                       | <b>Job No.</b> B269                                | <b>Unit No.</b> 999 |              |
|                                                                                                        | Neutral                                |                       |                                                    |                     |              |
| 34.                                                                                                    | Neutral CT specification:              |                       |                                                    |                     |              |
|                                                                                                        | 51G                                    |                       |                                                    |                     |              |
|                                                                                                        | HV side                                | VA                    | During Detail Engg.                                | CL 5P10             |              |
|                                                                                                        | LV-1 side                              | VA                    | During Detail Engg.                                | CL 5P10             |              |
|                                                                                                        | LV-2 side                              | VA                    |                                                    |                     |              |
|                                                                                                        | 64R                                    |                       | CL PS                                              |                     |              |
|                                                                                                        | HV side                                |                       |                                                    |                     |              |
|                                                                                                        | Vk                                     | V                     | During Detail Engg                                 |                     |              |
|                                                                                                        | Im at Vk/2                             | mA                    | During Detail Engg                                 |                     |              |
|                                                                                                        | RCT                                    | ohm                   | During Detail Engg                                 |                     |              |
|                                                                                                        | LV-1 side                              |                       |                                                    |                     |              |
|                                                                                                        | Vk                                     | V                     | During Detail Engg                                 |                     |              |
|                                                                                                        | Im at Vk/2                             | mA                    | During Detail Engg                                 |                     |              |
|                                                                                                        | RCT                                    | ohm                   | During Detail Engg                                 |                     |              |
|                                                                                                        | LV-2 side                              |                       |                                                    |                     |              |
|                                                                                                        | Vk                                     | V                     | Not applicable                                     |                     |              |
|                                                                                                        | Im at Vk/2                             | mA                    | Not applicable                                     |                     |              |
|                                                                                                        | RCT                                    | ohm                   | Not applicable                                     |                     |              |
| 35.                                                                                                    | Installation                           |                       | Outdoor                                            |                     |              |
| 36.                                                                                                    | Painting & colour                      |                       | Epoxy & Shade RAL 7031                             |                     |              |
| 37.                                                                                                    | AC Auxiliary voltage                   | V                     | 415 +/- 10 % TPN                                   |                     |              |
| 38.                                                                                                    | Bidirectional roller type              |                       | Flat                                               |                     |              |
| 39.                                                                                                    | φ distance of flat rollers             | mm                    | 1754                                               |                     |              |
| 40.                                                                                                    | Applicable specifications              |                       | EIL Specification 6-51-0068                        |                     |              |
| 41.                                                                                                    | Loss Capitalization                    |                       | Not applicable                                     |                     |              |
|                                                                                                        | Rate for copper loss Rs./kW:           |                       |                                                    |                     |              |
|                                                                                                        | Rate for iron loss Rs./kW:             |                       |                                                    |                     |              |
|                                                                                                        | Rate for aux. loss Rs./kW:             |                       |                                                    |                     |              |
| 42.                                                                                                    | ECS interface                          |                       |                                                    |                     |              |
|                                                                                                        | Digital output from RTCC:              |                       | Required                                           |                     |              |
|                                                                                                        | Tap changer out of step                |                       | Required                                           |                     |              |
|                                                                                                        | Tap changer stuck                      |                       | Required                                           |                     |              |
|                                                                                                        | Tap changer status signal              |                       | Required                                           |                     |              |
|                                                                                                        | Supply failure                         |                       | Required                                           |                     |              |
|                                                                                                        | Individual/Parallel mode               |                       | Required                                           |                     |              |
|                                                                                                        | Raiser/Lower control                   |                       | Required                                           |                     |              |
|                                                                                                        | Digital o/p from cooling control panel |                       | Required                                           |                     |              |
|                                                                                                        | Fan 'ON' (for each fan)                |                       | Required                                           |                     |              |
|                                                                                                        | Fan 'Tripped'(for each fan)            |                       | Required                                           |                     |              |
|                                                                                                        | Auto manual mode                       |                       | Required                                           |                     |              |
| 43.                                                                                                    | Accessories requirement                |                       |                                                    |                     |              |
|                                                                                                        | Sampling valve                         |                       | Yes                                                |                     |              |
|                                                                                                        | Conservator drain valve                |                       | Yes                                                |                     |              |
|                                                                                                        | Top oil filter valve                   |                       | Yes                                                |                     |              |
|                                                                                                        |                                        |                       |                                                    |                     |              |
| D                                                                                                      | 08-APR-2022                            | ISSUED WITH MR        | VVSN MURTY VALLEM                                  | HARISH KUMAR        | HARISH KUMAR |
| C                                                                                                      | 01-APR-2022                            | ISSUED WITH MR        | VVSN MURTY VALLEM                                  | MANISH KUMAR        | HARISH KUMAR |
| B                                                                                                      | 20-NOV-2020                            | ISSUED WITH MR/TENDER | ANIL KUMAR GARHWAL                                 | HARISH KUMAR        | HARISH KUMAR |
| A                                                                                                      | 12-MAY-2020                            | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN                                 | 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**

**Job No.** B269

**Unit No.** 999

|     |                                                              |                                               |
|-----|--------------------------------------------------------------|-----------------------------------------------|
|     | Explosion vent/PRV                                           | Yes                                           |
|     | Air bag for conservator                                      | Yes                                           |
|     | Dial type thermometer & contacts for OTI, WTI                | Yes (See Notes)                               |
|     | Drain valve                                                  | Yes                                           |
|     | Marshalling box                                              | Yes                                           |
|     | Double float Buchholz                                        | Yes                                           |
|     | Channels, towing lugs :                                      | Yes                                           |
|     | Rollers                                                      | Yes                                           |
|     | Neutral bushing outside terminal box with connector assembly | Yes                                           |
|     | Inspection cover                                             | Yes                                           |
|     | Disconnecting chamber                                        | Yes                                           |
|     | WTI & OTI                                                    | Yes                                           |
|     | Busduct flange on LV                                         | Yes                                           |
|     | Lugs and cable glands                                        | Yes                                           |
| 44. | OLTC accessories                                             |                                               |
|     | Single float Buchholz/oil surge relay                        | Yes                                           |
| 45. | Additional loose supply                                      |                                               |
|     | Tap position indicator                                       | No                                            |
|     | Raise/lower push buttons                                     | No                                            |
|     | Transducers and necessary interface                          | No                                            |
| 46. | Tests requirements                                           |                                               |
|     | Impulse test:                                                | Test Certificate to be furnished (See Note-8) |
|     | Heat run test                                                | Required (See Notes-6 & 8)                    |
|     | Short circuit test (On Transformer) :                        | Test Certificate to be furnished (See Note-8) |
|     | Short circuit test (On Terminal box) :                       | Test Certificate to be furnished (See Note-8) |
|     | Vaccum test on tank                                          | Required (See Note-9)                         |
|     | Pressure test on tank                                        | Required (See Note-9)                         |
|     | Oil leakage test                                             | Required                                      |

#### MANUFACTURER'S DATA

|                                     |    |
|-------------------------------------|----|
| <b>A. Make:</b>                     |    |
| <b>Rating MVA</b>                   |    |
| <b>B. Performance</b>               |    |
| 1. No load loss at                  |    |
| 100% Voltage :                      | kW |
| 110% Voltage :                      | kW |
| 2. Full load copper loss at 75 °C   | kW |
| 3. Auxillary losses:                | kW |
| 4. No load current at               |    |
| 100% Voltage :                      | A  |
| 110% Voltage :                      | A  |
| 5. Efficiency at full load at 75 °C |    |
| at 0.8 p.f.                         | %  |
| at 1.0 p.f.                         | %  |
| 6. Eff.at 50% load at 75 °C         |    |
| at 0.8 p.f.                         | %  |
| at 1.0 p.f.                         | %  |

|          |             |                       |                    |              |              |
|----------|-------------|-----------------------|--------------------|--------------|--------------|
| D        | 08-APR-2022 | ISSUED WITH MR        | VVSN MURTY VALLEM  | HARISH KUMAR | HARISH KUMAR |
| C        | 01-APR-2022 | ISSUED WITH MR        | VVSN MURTY VALLEM  | MANISH KUMAR | HARISH KUMAR |
| B        | 20-NOV-2020 | ISSUED WITH MR/TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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**

**Job No.** B269

**Unit No.** 999

|          |                                  |       |
|----------|----------------------------------|-------|
| 7.       | Maximum efficiency:              |       |
|          | at 0.8 p.f.                      | %     |
|          | at 1.0 p.f.                      | %     |
| 8.       | Load at which max eff. Occurs:   |       |
|          | at 0.8 p.f.                      | MVA   |
|          | at 1.0 p.f.                      | MVA   |
| 9.       | Regulation at 75 C               |       |
|          | at 0.8 p.f.                      | %     |
|          | at 1.0 p.f.                      | %     |
| 10.      | X1/R1 Ratio                      |       |
|          | X0/R0 Ratio                      |       |
| 11.      | Zero sequence in impedance, Z0   |       |
| 12.      | Inrush Current                   | A     |
| 13.      | Duration of Inrush Current       | Sec   |
| 14.      | Value of Permissible Overloading |       |
|          | For 0.5 Hrs                      | %     |
|          | For 1 Hrs                        | %     |
|          | For 2 Hrs                        | %     |
|          | For 4 Hrs                        | %     |
|          | For 6 Hrs                        | %     |
|          | For 8 Hrs                        | %     |
|          | For 12 Hrs                       | %     |
|          | For 24 Hrs                       | %     |
| <b>C</b> | <b>Construction features</b>     |       |
| 1.       | Location of terminals            |       |
|          | Primary                          |       |
| 2.       | No of cooler banks               |       |
| 3.       | Qty of cooling fans:             |       |
|          | Working:                         | Nos.  |
|          | Standby:                         | Nos.  |
| 4.       | Location of Neutral CT           |       |
| 5.       | Explosion Protection             |       |
| 6.       | OLTC Specification:              |       |
|          | Rated Voltage                    | kV    |
|          | Rated Current                    | A     |
|          | Location                         |       |
|          | Accessories                      |       |
| <b>D</b> | <b>Mechanical Data</b>           |       |
| 1.       | Core & winding weight            | kgs.  |
| 2.       | Tank & fitting weight            | kgs.  |
| 3.       | Radiator without oil weight      | kgs.  |
| 4.       | Total weight                     | kgs.  |
| 5.       | Total quantity of oil :          | kgs.  |
| 6.       | Quantity of oil in radiators :   | ltrs. |
| 7.       | Qty of oil in OLTC chamber       | ltrs. |
| 8.       | Overall dimensions               |       |
|          | Length                           | mm    |

|          |             |                       |                    |              |              |
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| B        | 20-NOV-2020 | ISSUED WITH MR/TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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**

**Job No.** B269

**Unit No.** 999

Breadth

mm

Height

mm

**Notes**

- 1 Performance data shall be furnished for ONAN rating.
- 2 Minimum guaranteed efficiency at 0.8 pf at 40% of ONAN rating shall be 99.5% (inclusive of tolerance)
- 3 Make of components shall be as per vendor list enclosed.
- 4 Losses shall be inclusive of positive tolerance and shall be at nominal tap.
- 5 Transducers for providing 4-20mA signal for OTI and WTI for owner interface shall be provided.
- 6 Heat Run test shall be conducted on one transformer of each rating.
- 7 Following details shall be submitted for scrutiny after design finalization :
  - a.) Yoke lamination bonding
  - b.) Type of core joint
  - c.) Number of laminations / lay
  - d.) Overlap length
  - e.) Angle of overlap
  - f.) Gap at joints
  - g.) Operation flux density
  - h.) Proportion of corner weight
  - i.) X0/X1
  - j.) X/R
  - k.) Z variation at +/-10% tap position
- 8 Vendor to ensure that valid type test certificates for offered design of transformer are available for heat run test, short circuit test and impulse test. The same shall also be furnished for Owner's record during detail engineering. In case the valid type test certificates are not available, bidder shall carryout the type tests without any additional cost and time implication to Owner/EIL. In case of non-availability of short circuit test reports, manufacturer certified comparative statement in line with IEC-60076 part 5 / IS 2026 part 5 shall be furnished.
- 9 Pressure test and vacuum test shall be conducted at vendors works on one transformer tank of each size.
- 10 String insulators with high creepage distances shall be used in terminal box of transformers.
- 11 Pollution level for all outdoor electrical equipments shall be considered as heavy

|          |             |                       |                    |              |              |
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| B        | 20-NOV-2020 | ISSUED WITH MR/TENDER | ANIL KUMAR GARHWAL | HARISH KUMAR | HARISH KUMAR |
| A        | 12-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | 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>                            |                    | <b>Job No.</b>  | B269                                 |
|                                 |                                                                                         |                                            |                    | <b>Unit No.</b> | 999                                  |
| <b>PURCHASER'S DATA</b>         |                                                                                         |                                            |                    |                 |                                      |
| <b>A. Site Conditions</b>       |                                                                                         |                                            |                    |                 |                                      |
| 1.                              | Maximum Ambient Temperature                                                             | °C                                         | 50                 |                 |                                      |
| 2.                              | Minimum Ambient Temperature                                                             | °C                                         | 5                  |                 |                                      |
| 3.                              | Design Ambient Temperature                                                              | °C                                         | 45                 |                 |                                      |
| 4.                              | Relative Humidity                                                                       | %                                          | 90                 |                 |                                      |
| 5.                              | Altitude Above MSL                                                                      | mm                                         | 1000               |                 |                                      |
| 6.                              | Environment                                                                             | Hot, Humid & Corrosive                     |                    |                 |                                      |
| <b>B. Technical particulars</b> |                                                                                         |                                            |                    |                 |                                      |
| 1.                              | Rated voltage                                                                           | Volts                                      | 6.6/v3             |                 |                                      |
| 2.                              | Rated current (short time rating)                                                       | A                                          |                    |                 |                                      |
| 3.                              | Short time rating                                                                       | 10 Sec.                                    |                    |                 |                                      |
| 4.                              | Continuous rating (10% of short time rating)                                            | Not Required                               |                    |                 |                                      |
| 5.                              | Resistance of NGR                                                                       | Ohms                                       |                    |                 |                                      |
| 6.                              | Terminal connections                                                                    |                                            |                    |                 |                                      |
| 6.1                             | Transformer neutral to NGR                                                              |                                            |                    |                 |                                      |
|                                 | Cable size                                                                              | sq. mm.                                    |                    |                 |                                      |
|                                 | Voltage grade                                                                           | kV (E/UE)                                  |                    |                 |                                      |
| 6.2                             | NGR to Earth                                                                            |                                            |                    |                 |                                      |
|                                 | Size                                                                                    | sq. mm.                                    |                    |                 |                                      |
|                                 | Voltage grade                                                                           | kV (E/UE)                                  |                    |                 |                                      |
| 7.                              | Installation                                                                            | Outdoor                                    |                    |                 |                                      |
| 8.                              | Cable connections                                                                       |                                            |                    |                 |                                      |
| 8.1                             | Cable entry                                                                             | Bottom                                     |                    |                 |                                      |
| 8.2                             | Separate bolted removable gland plate for cable entry                                   | Required                                   |                    |                 |                                      |
| 8.3                             | Cable glands & lugs                                                                     | Required                                   |                    |                 |                                      |
| 9.                              | Current transformer                                                                     | Not Required                               |                    |                 |                                      |
|                                 | Voltage grade                                                                           |                                            |                    |                 |                                      |
|                                 | Ratio                                                                                   |                                            |                    |                 |                                      |
|                                 | Burden                                                                                  |                                            |                    |                 |                                      |
|                                 | Accuracy class                                                                          |                                            |                    |                 |                                      |
| 10.                             | Painting/Painting shade                                                                 | Epoxy & shade RAL 7031                     |                    |                 |                                      |
| 11.                             | Degree of protection                                                                    | IP31 for Enclosure, IP 55 For Terminal Box |                    |                 |                                      |
| 12.                             | Applicable EIL specification                                                            | 6-51-0043                                  |                    |                 |                                      |
| <b>MANUFACTURER'S DATA</b>      |                                                                                         |                                            |                    |                 |                                      |
| <b>A. Technical particulars</b> |                                                                                         |                                            |                    |                 |                                      |
| 1.                              | Make                                                                                    |                                            |                    |                 |                                      |
| 2.                              | Resistor element                                                                        |                                            |                    |                 |                                      |
|                                 | Material code                                                                           |                                            |                    |                 |                                      |
|                                 | Specific resistance                                                                     | ohm cm                                     |                    |                 |                                      |
|                                 | Temp. co-efficient                                                                      |                                            |                    |                 |                                      |
|                                 | Resistance of banks                                                                     | ohms                                       |                    |                 |                                      |
|                                 | No. of resistor banks                                                                   |                                            |                    |                 |                                      |
|                                 | Series                                                                                  | nos.                                       |                    |                 |                                      |
|                                 | Parallel (Min.two)                                                                      | nos..                                      |                    |                 |                                      |
| 3.                              | Separate canopy provided                                                                |                                            |                    |                 |                                      |
|                                 |                                                                                         |                                            |                    |                 |                                      |
|                                 |                                                                                         |                                            |                    |                 |                                      |
|                                 |                                                                                         |                                            |                    |                 |                                      |
| A                               | 13-MAY-2020                                                                             | ISSUED WITH MR/TENDER                      | JAYENDRA L CHAUHAN | 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                                   | Job No. B269                                | Unit No. 999 |
| 4.                                                                                              | Min. creepage distance                     |                                             |              |
|                                                                                                 | Total mm                                   |                                             |              |
|                                                                                                 | Protected mm                               |                                             |              |
| 5.                                                                                              | P.f withstand voltage kV (rms)             |                                             |              |
| 6.                                                                                              | Overall dimensions                         |                                             |              |
|                                                                                                 | Width mm                                   |                                             |              |
|                                                                                                 | Depth mm                                   |                                             |              |
|                                                                                                 | Height mm                                  |                                             |              |
| 7.                                                                                              | Overall weight of panel kg                 |                                             |              |
| 8.                                                                                              | Copies of type test certificates furnished |                                             |              |

#### Eil Notes

1

|          |             |                       |                    |              |              |
|----------|-------------|-----------------------|--------------------|--------------|--------------|
|          |             |                       |                    |              |              |
|          |             |                       |                    |              |              |
|          |             |                       |                    |              |              |
| A        | 13-MAY-2020 | ISSUED WITH MR/TENDER | JAYENDRA L CHAUHAN | HARISH KUMAR | HARISH KUMAR |
| Rev. No. | Date        | Purpose               | Prepared By        | Reviewed By  | Approved By  |



# TYPICAL ECS I/O LIST FOR ELECTRICAL CONTROL SYSTEM

**PROJECT : PANIPAT REFINERY EXPANSION (P-25) PROJECT**

**OWNER : M/s INDIAN OIL CORPORATION LTD.**

**EPMC : ENGINEERS INDIA LTD.**

|         |            |                |             |            |             |
|---------|------------|----------------|-------------|------------|-------------|
|         |            |                |             |            |             |
|         |            |                |             |            |             |
|         |            |                |             |            |             |
|         |            |                |             |            |             |
| A       | 13.09.2021 | ISSUED WITH MR | SNM         | AKG/RS     | HK          |
| Rev. No | Date       | Purpose        | Prepared by | Checked by | Approved by |

**This ECS I/O list is applicable for the 6.6kV HV Switchgear in substations**

ECS I/O List

| Type                                    | Pt type | Description                          | Set condition | Reset condition | Interface | Remarks                                |
|-----------------------------------------|---------|--------------------------------------|---------------|-----------------|-----------|----------------------------------------|
| <b>INCOMER FROM TRANSFORMER</b>         |         |                                      |               |                 |           |                                        |
| DI                                      | S       | Ready to close                       |               |                 | RELAY LAN |                                        |
| DI                                      | S       | Synch. OK                            |               |                 | RELAY LAN |                                        |
| DI                                      | D       | Over Current                         |               |                 | RELAY LAN |                                        |
| DI                                      | D       | Earth Fault                          |               |                 | RELAY LAN |                                        |
| DI                                      | D       | 51G Operated                         |               |                 | RELAY LAN |                                        |
| DI                                      | D       | Under Voltage                        |               |                 | RELAY LAN |                                        |
| DI                                      | D       | Reverse BLOCKING activated           |               |                 | RELAY LAN |                                        |
| DI                                      | D       | 64R Operated                         |               |                 | RELAY LAN |                                        |
| AI                                      | A       | R phase current                      |               |                 | RELAY LAN |                                        |
| AI                                      | A       | Y phase current                      |               |                 | RELAY LAN |                                        |
| AI                                      | A       | B phase current                      |               |                 | RELAY LAN |                                        |
| AI                                      | W       | 3-Phase Real Power                   |               |                 | RELAY LAN |                                        |
| AI                                      | R       | 3-Phase Reactive Power               |               |                 | RELAY LAN |                                        |
| AI                                      |         | Power Factor                         |               |                 | RELAY LAN |                                        |
| AI                                      |         | Frequency                            |               |                 | RELAY LAN |                                        |
| DI                                      | S       | CB in service &                      | Closed        | Not closed      | HARDWIRED |                                        |
| DI                                      | S       | CB in service &                      | Open          | Not open        | HARDWIRED |                                        |
| DI                                      | D       | Relay 86                             | Operated      | Reset           | HARDWIRED |                                        |
| DI                                      | D       | Relay 95                             | Operated      | Reset           | RELAY LAN |                                        |
| DI                                      | D       | Trip on under voltage                | Activated     | Reset           | RELAY LAN |                                        |
| DI                                      | D       | Numerical Relays                     | Unhealthy     | Healthy         | RELAY LAN |                                        |
| DO                                      | C       | Trip from ECS                        | Activated     | Reset           | HARDWIRED |                                        |
| DO                                      | C       | Close Inhibit (From ECS)             | Operated      | Reset           | HARDWIRED |                                        |
| DI                                      | D       | Trafo Trouble Alarm (Buch., OTI,WTI) |               |                 | RELAY LAN |                                        |
| DI                                      | D       | Trafo Trouble Trip (Buch., OTI,WTI)  |               |                 | RELAY LAN |                                        |
| AI                                      | T       | Oil Temperature                      |               |                 | HARDWIRED | 4-20mA through transducers in Trafo MB |
| AI                                      | T       | Winding Temperature                  |               |                 | HARDWIRED |                                        |
| DI                                      | D       | Transformer Differential             | Operated=1    |                 | RELAY LAN | 87T                                    |
| DI                                      | D       | Over Temperature monitoring system   | Operated      | Reset           | HARDWIRED |                                        |
| <b>INCOMER FROM ANOTHER SWITCHBOARD</b> |         |                                      |               |                 |           |                                        |
| AI                                      | A       | R phase current                      |               |                 | RELAY LAN |                                        |
| AI                                      | A       | Y phase current                      |               |                 | RELAY LAN |                                        |
| AI                                      | A       | B phase current                      |               |                 | RELAY LAN |                                        |
| AI                                      | W       | 3-Phase Real Power                   |               |                 | RELAY LAN |                                        |
| AI                                      | R       | 3-Phase Reactive Power               |               |                 | RELAY LAN |                                        |

| Type                 | Pt type | Description                         | Set condition | Reset condition | Interface | Remarks |
|----------------------|---------|-------------------------------------|---------------|-----------------|-----------|---------|
| AI                   |         | Power Factor                        |               |                 | RELAY LAN |         |
| AI                   |         | Frequency                           |               |                 | RELAY LAN |         |
| DI                   | S       | CB in service &                     | Closed        | Not closed      | HARDWIRED |         |
| DI                   | S       | CB in service &                     | Open          | Not open        | HARDWIRED |         |
| DI                   | D       | Relay 86                            | Operated      | Reset           | HARDWIRED |         |
| DI                   | D       | Relay 95                            | Operated      | Reset           | RELAY LAN |         |
| DI                   | D       | Trip on under voltage               | Activated     | Reset           | RELAY LAN |         |
| DI                   | D       | Numerical Relays                    | Unhealthy     | Healthy         | RELAY LAN |         |
| DO                   | C       | Trip from ECS                       | Activated     | Reset           | HARDWIRED |         |
| DO                   | C       | Close Inhibit (From ECS)            | Operated      | Reset           | HARDWIRED |         |
| DI                   | D       | Feeder Differential                 | Operated=1    |                 | RELAY LAN | 87F     |
| DI                   | D       | Over Temperature monitoring system  | Operated      | Reset           | HARDWIRED |         |
| <b>LINE PT</b>       |         |                                     |               |                 |           |         |
| AI                   | V       | R-Y Line Voltage                    |               |                 | RELAY LAN |         |
| AI                   | V       | Y-B Line Voltage                    |               |                 | RELAY LAN |         |
| AI                   | V       | R-B Line Voltage                    |               |                 | RELAY LAN |         |
| DI                   | D       | Line PT Secondary MCB               | Tripped=1     |                 | HARDWIRED |         |
| <b>BUS COUPLER-1</b> |         |                                     |               |                 |           |         |
| AI                   | A       | R phase current                     |               |                 | RELAY LAN |         |
| AI                   | A       | Y phase current                     |               |                 | RELAY LAN |         |
| AI                   | A       | B phase current                     |               |                 | RELAY LAN |         |
| AI                   | W       | 3-Phase Real Power (Bi-directional) |               |                 | RELAY LAN |         |
| AI                   | R       | 3-Phase Reactive Power              |               |                 | RELAY LAN |         |
| AI                   |         | Power Factor                        |               |                 | RELAY LAN |         |
| DI                   | S       | CB in service &                     | Closed        | Not closed      | HARDWIRED |         |
| DI                   | S       | CB in service &                     | Open          | Not open        | HARDWIRED |         |
| DI                   | D       | Relay 86                            | Operated      | Reset           | HARDWIRED |         |
| DI                   | D       | Relay 95                            | Operated      | Reset           | RELAY LAN |         |
| DI                   | D       | Trip on under voltage               | Activated     | Reset           | RELAY LAN |         |
| DI                   | D       | Numerical Relays                    | Unhealthy     | Healthy         | RELAY LAN |         |
| DO                   | C       | Trip from ECS                       | Activated     | Reset           | HARDWIRED |         |
| DO                   | C       | Close Inhibit (From ECS)            | Operated      | Reset           | HARDWIRED |         |
| DI                   | D       | Auto-changeover                     | Blocked       | Not blocked     | HARDWIRED |         |
| DI                   | S       | Switchboard (A-I-M selector switch) | Auto          |                 | HARDWIRED |         |
| DI                   | S       | Switchboard (A-I-M selector switch) | Independent   |                 | HARDWIRED |         |
| DI                   | S       | Switchboard (A-I-M selector switch) | Manual        |                 | HARDWIRED |         |
| DI                   | D       | AC control supply #1                | Failed        | Healthy         | HARDWIRED |         |

| Type                               | Pt type | Description                          | Set condition | Reset condition | Interface | Remarks        |
|------------------------------------|---------|--------------------------------------|---------------|-----------------|-----------|----------------|
| DI                                 | D       | AC control supply #2                 | Failed        | Healthy         | HARDWIRED |                |
| DI                                 | D       | DC control supply #1                 | Failed        | Healthy         | HARDWIRED |                |
| DI                                 | D       | DC control supply #2                 | Failed        | Healthy         | HARDWIRED |                |
| DI                                 | S       | Ready to close                       |               |                 | RELAY LAN |                |
| DI                                 | S       | Synch. OK                            |               |                 | RELAY LAN |                |
| DI                                 | D       | Over Current / Earth Fault           |               |                 | RELAY LAN |                |
| DI                                 | D       | Auto-changeover                      | Blocked       | Not blocked     | RELAY LAN |                |
| DI                                 | S       | I/C-1 Under Voltage                  |               |                 | RELAY LAN |                |
| DI                                 | S       | I/C-2 Under Voltage                  |               |                 | RELAY LAN |                |
| DI                                 | D       | Reverse BLOCKING activated           |               |                 | RELAY LAN |                |
| <b>BUS COUPLER-2</b>               |         |                                      |               |                 |           |                |
| DI                                 | S       | CB in service &                      | Closed        | Not closed      | HARDWIRED |                |
| DI                                 | S       | CB in service &                      | Open          | Not open        | HARDWIRED |                |
| DI                                 | D       | Relay 86                             | Operated      | Reset           | HARDWIRED |                |
| DI                                 | D       | Relay 95                             | Operated      | Reset           | HARDWIRED |                |
| <b>OUTGOING TRANSFORMER FEEDER</b> |         |                                      |               |                 |           |                |
| AI                                 | A       | R phase current                      |               |                 | RELAY LAN |                |
| AI                                 | A       | Y phase current                      |               |                 | RELAY LAN |                |
| AI                                 | A       | B phase current                      |               |                 | RELAY LAN |                |
| AI                                 | W       | 3-Phase Real Power                   |               |                 | RELAY LAN |                |
| AI                                 | R       | 3-Phase Reactive Power               |               |                 | RELAY LAN |                |
| AI                                 |         | Power Factor                         |               |                 | RELAY LAN |                |
| AI                                 |         | Frequency                            |               |                 | RELAY LAN |                |
| DI                                 | S       | CB in service &                      | Closed        | Not closed      | HARDWIRED |                |
| DI                                 | S       | CB in service &                      | Open          | Not open        | HARDWIRED |                |
| DI                                 | D       | Relay 86                             | Operated      | Reset           | HARDWIRED |                |
| DI                                 | D       | Relay 95                             | Operated      | Reset           | RELAY LAN |                |
| DI                                 | D       | Trip on under voltage                | Activated     | Reset           | RELAY LAN |                |
| DI                                 | D       | Numerical Relay                      | Unhealthy     | Healthy         | RELAY LAN |                |
| DO                                 | C       | Trip from ECS                        | Activated     | Reset           | HARDWIRED |                |
| DO                                 | C       | Close Inhibit (From ECS)             | Operated      | Reset           | HARDWIRED |                |
| DI                                 | D       | Transformer Trouble                  | Operated=1    |                 | RELAY LAN | 63TX, 51G, 64R |
| DO                                 | C       | Outgoing trafo fdr re-closing        | Activated     | Reset           | HARDWIRED |                |
| DI                                 | S       | Ready to close                       |               |                 | RELAY LAN |                |
| DI                                 | D       | Over Current                         |               |                 | RELAY LAN |                |
| DI                                 | D       | Earth Fault                          |               |                 | RELAY LAN |                |
| DI                                 | D       | Trafo Trouble Alarm (Buch., OTI,WTI) |               |                 | RELAY LAN |                |
| DI                                 | D       | Trafo Trouble Trip (Buch., OTI,WTI)  |               |                 | RELAY LAN |                |
| DI                                 | D       | 64R from Downstream                  |               |                 | RELAY LAN |                |

| Type                             | Pt type | Description                    | Set condition | Reset condition | Interface | Remarks |
|----------------------------------|---------|--------------------------------|---------------|-----------------|-----------|---------|
| DI                               | D       | Reverse BLOCKING activated     |               |                 | RELAY LAN |         |
| DI                               | D       | 51G from Downstream            |               |                 | RELAY LAN |         |
| <b>OUTGOING PLANT FEEDER</b>     |         |                                |               |                 |           |         |
| AI                               | A       | R phase current                |               |                 | RELAY LAN |         |
| AI                               | A       | Y phase current                |               |                 | RELAY LAN |         |
| AI                               | A       | B phase current                |               |                 | RELAY LAN |         |
| AI                               | W       | 3-Phase Real Power             |               |                 | RELAY LAN |         |
| AI                               | R       | 3-Phase Reactive Power         |               |                 | RELAY LAN |         |
| AI                               |         | Power Factor                   |               |                 | RELAY LAN |         |
| DI                               | S       | CB in service &                | Closed        | Not closed      | HARDWIRED |         |
| DI                               | S       | CB in service &                | Open          | Not open        | HARDWIRED |         |
| DI                               | D       | Relay 86                       | Operated      | Reset           | HARDWIRED |         |
| DI                               | D       | Relay 95                       | Operated      | Reset           | RELAY LAN |         |
| DI                               | D       | Trip on under voltage          | Activated     | Reset           | RELAY LAN |         |
| DI                               | D       | Numerical Relays               | Unhealthy     | Healthy         | RELAY LAN |         |
| DO                               | C       | Trip from ECS                  | Activated     | Reset           | HARDWIRED |         |
| DI                               | D       | Feeder Differential            | Operated=1    |                 | RELAY LAN |         |
| DI                               | S       | Ready to close                 |               |                 | RELAY LAN |         |
| DI                               | D       | Over Current                   |               |                 | RELAY LAN |         |
| DI                               | D       | Earth Fault                    |               |                 | RELAY LAN |         |
| DI                               | D       | Reverse BLOCKING activated     |               |                 | RELAY LAN |         |
| DI                               | D       | Line Differential Operated     |               |                 | RELAY LAN |         |
| <b>OUTGOING CAPACITOR FEEDER</b> |         |                                |               |                 |           |         |
| AI                               | A       | R phase current                |               |                 | RELAY LAN |         |
| AI                               | A       | Y phase current                |               |                 | RELAY LAN |         |
| AI                               | A       | B phase current                |               |                 | RELAY LAN |         |
| AI                               | R       | 3-Phase Reactive Power         |               |                 | RELAY LAN |         |
| AI                               | R       | 3-Phase Reactive Power         |               |                 | RELAY LAN |         |
| AI                               |         | Power Factor                   |               |                 | RELAY LAN |         |
| DI                               | S       | CB in service &                | Closed        | Not closed      | HARDWIRED |         |
| DI                               | S       | CB in service &                | Open          | Not open        | HARDWIRED |         |
| DI                               | D       | Relay 86                       | Operated      | Reset           | HARDWIRED |         |
| DI                               | D       | Relay 95                       | Operated      | Reset           | RELAY LAN |         |
| DI                               | D       | Trip on under voltage          | Activated     | Reset           | RELAY LAN |         |
| DI                               | D       | Numerical Relay                | Unhealthy     | Healthy         | RELAY LAN |         |
| DO                               | C       | Close from ECS                 | Activated     | Reset           | HARDWIRED |         |
| DO                               | C       | Trip from ECS                  | Activated     | Reset           | HARDWIRED |         |
| DI                               | S       | Local / ECS Selector Switch in | LOCAL         | Not_Local       | HARDWIRED |         |
| DI                               | S       | Local / ECS Selector Switch in | ECS           | Not_ECS         | HARDWIRED |         |

| Type                         | Pt type | Description                      | Set condition | Reset condition | Interface | Remarks                                    |
|------------------------------|---------|----------------------------------|---------------|-----------------|-----------|--------------------------------------------|
| DI                           | S       | Ready to close                   |               |                 | RELAY LAN |                                            |
| DI                           | D       | Over Current                     |               |                 | RELAY LAN |                                            |
| DI                           | D       | Earth Fault                      |               |                 | RELAY LAN |                                            |
| DI                           | D       | Over Voltage                     |               |                 | RELAY LAN |                                            |
| DI                           | D       | Under Voltage                    |               |                 | RELAY LAN |                                            |
| DI                           | D       | Reverse BLOCKING activated       |               |                 | RELAY LAN |                                            |
| <b>OUTGOING MOTOR FEEDER</b> |         |                                  |               |                 |           |                                            |
| DI                           | D       | Motor Differential Operated      |               |                 | RELAY LAN | Applicable for motors $\geq 1500\text{kW}$ |
| AI                           | A       | R phase current                  |               |                 | RELAY LAN |                                            |
| AI                           | A       | Y phase current                  |               |                 | RELAY LAN |                                            |
| AI                           | A       | B phase current                  |               |                 | RELAY LAN |                                            |
| AI                           | W       | 3-Phase Real Power               |               |                 | RELAY LAN |                                            |
| AI                           | R       | 3-Phase Reactive Power           |               |                 | RELAY LAN |                                            |
| AI                           |         | Power Factor                     |               |                 | RELAY LAN |                                            |
| DI                           | S       | CB in service &                  | Closed        | Not closed      | HARDWIRED |                                            |
| DI                           | S       | CB in service &                  | Open          | Not open        | HARDWIRED |                                            |
| DI                           | D       | Relay 86                         | Operated      | Reset           | HARDWIRED |                                            |
| DI                           | D       | Relay 95                         | Operated      | Reset           | RELAY LAN |                                            |
| DI                           | D       | Trip on under voltage            | Activated     | Reset           | RELAY LAN |                                            |
| DI                           | D       | Numerical Relays                 | Unhealthy     | Healthy         | RELAY LAN |                                            |
| DO                           | C       | Trip from ECS                    | Activated     | Reset           | HARDWIRED |                                            |
| DO                           | C       | Close Inhibit (From ECS)         | Operated      | Reset           | HARDWIRED |                                            |
| DI                           | D       | Motor Trip from Process          | Operated=1    |                 | HARDWIRED |                                            |
| DI                           | S       | Ready to close                   |               |                 | RELAY LAN |                                            |
| DI                           | D       | 49T/50/50LR                      |               |                 | RELAY LAN |                                            |
| DI                           | D       | Earth Fault                      |               |                 | RELAY LAN |                                            |
| DI                           | D       | Unbalance Trip                   |               |                 | RELAY LAN |                                            |
| DI                           | D       | Under Voltage Trip               |               |                 | RELAY LAN |                                            |
| DI                           | S       | Re-Acceleration                  |               |                 | RELAY LAN |                                            |
| DI                           | D       | Reverse BLOCKING activated       |               |                 | RELAY LAN |                                            |
| DI                           | D       | Process Trip                     |               |                 | RELAY LAN |                                            |
| DI                           | S       | Breaker 'ON' indication          |               |                 | RELAY LAN |                                            |
| DI                           | S       | Breaker 'OFF' indication         |               |                 | RELAY LAN |                                            |
| DI                           | S       | L/R switch in Local Indication   |               |                 | RELAY LAN |                                            |
| DI                           | S       | L/R switch in Remote Indication  |               |                 | RELAY LAN |                                            |
| DI                           | S       | Process Trip indication          |               |                 | RELAY LAN |                                            |
| DI                           | S       | Electrical fault trip indication |               |                 | RELAY LAN |                                            |



| Type                                   | Pt type | Description                           | Set condition | Reset condition | Interface         | Remarks        |
|----------------------------------------|---------|---------------------------------------|---------------|-----------------|-------------------|----------------|
| DI                                     | S       | Motor ready to start                  |               |                 | RELAY LAN         |                |
| <b>BUS PT</b>                          |         |                                       |               |                 |                   |                |
| AI                                     | V       | R-Y Line Voltage                      |               |                 | RELAY LAN         |                |
| AI                                     | V       | Y-B Line Voltage                      |               |                 | RELAY LAN         |                |
| AI                                     | V       | R-B Line Voltage                      |               |                 | RELAY LAN         |                |
| DI                                     | D       | Bus PT Secondary MCB                  | Tripped=1     |                 | HARDWIRED         |                |
| DI                                     | S       | Dead Bus (<40%)                       |               |                 | RELAY LAN         |                |
| DI                                     | D       | Under Voltage (<80%)                  |               |                 | RELAY LAN         |                |
| DI                                     | D       | BPT not in Service / PT MCB Unhealthy |               |                 | RELAY LAN         |                |
| DI                                     | D       | UF & df/dt Signal                     | Operated      | Reset           | Hardwired (4 Nos) |                |
| <b>OUTGOING VFD TRANSFORMER FEEDER</b> |         |                                       |               |                 |                   |                |
| AI                                     | A       | R phase current                       |               |                 | RELAY LAN         |                |
| AI                                     | A       | Y phase current                       |               |                 | RELAY LAN         |                |
| AI                                     | A       | B phase current                       |               |                 | RELAY LAN         |                |
| AI                                     | W       | 3-Phase Real Power                    |               |                 | RELAY LAN         |                |
| AI                                     | R       | 3-Phase Reactive Power                |               |                 | RELAY LAN         |                |
| AI                                     |         | Power Factor                          |               |                 | RELAY LAN         |                |
| DI                                     | S       | CB in service &                       | Closed        | Not closed      | HARDWIRED         |                |
| DI                                     | S       | CB in service &                       | Open          | Not open        | HARDWIRED         |                |
| DI                                     | D       | Relay 86                              | Operated      | Reset           | HARDWIRED         |                |
| DI                                     | D       | Relay 95                              | Operated      | Reset           | RELAY LAN         |                |
| DI                                     | D       | Trip on under voltage                 | Activated     | Reset           | RELAY LAN         |                |
| DI                                     | D       | Numerical Relay                       | Unhealthy     | Healthy         | RELAY LAN         |                |
| DO                                     | C       | Trip from ECS                         | Activated     | Reset           | HARDWIRED         |                |
| DO                                     | C       | Close Inhibit (From ECS)              | Operated      | Reset           | HARDWIRED         |                |
| DI                                     | D       | Transformer Trouble                   | Operated=1    |                 | RELAY LAN         | 63TX, 51G, 64R |
| DI                                     | S       | Ready to close                        |               |                 | RELAY LAN         |                |
| DI                                     | D       | Over Current                          |               |                 | RELAY LAN         |                |
| DI                                     | D       | Earth Fault                           |               |                 | RELAY LAN         |                |
| DI                                     | D       | Trafo Trouble Alarm (Buch., OTI, WTI) |               |                 | RELAY LAN         |                |
| DI                                     | D       | Trafo Trouble Trip (Buch., OTI, WTI)  |               |                 | RELAY LAN         |                |
| DI                                     | D       | Trip from VFD                         |               |                 | RELAY LAN         |                |
| DI                                     | D       | Reverse BLOCKING activated            |               |                 | RELAY LAN         |                |
| <b>ISOLATING BREAKER PANEL</b>         |         |                                       |               |                 |                   |                |
| AI                                     | W       | 3-Phase Real Power                    |               |                 | RELAY LAN         |                |
| AI                                     | R       | 3-Phase Reactive Power                |               |                 | RELAY LAN         |                |
| AI                                     |         | Power Factor                          |               |                 | RELAY LAN         |                |
| DI                                     | D       | Line PT Secondary MCB                 | Tripped=1     |                 | HARDWIRED         |                |

| Type                             | Pt type | Description                                                               | Set condition | Reset condition | Interface | Remarks                                                                                                                |
|----------------------------------|---------|---------------------------------------------------------------------------|---------------|-----------------|-----------|------------------------------------------------------------------------------------------------------------------------|
| DI                               | S       | CB in service &                                                           | Closed        | Not closed      | HARDWIRED |                                                                                                                        |
| DI                               | S       | CB in service &                                                           | Open          | Not open        | HARDWIRED |                                                                                                                        |
| DI                               | D       | Relay 86                                                                  | Operated      | Reset           | HARDWIRED |                                                                                                                        |
| DI                               | D       | Relay 95                                                                  | Operated      | Reset           | RELAY LAN |                                                                                                                        |
| DI                               | D       | Trip on under voltage                                                     | Activated     | Reset           | RELAY LAN |                                                                                                                        |
| DI                               | D       | Numerical Relays                                                          | Unhealthy     | Healthy         | RELAY LAN |                                                                                                                        |
| DO                               | C       | Trip from ECS                                                             | Activated     | Reset           | HARDWIRED |                                                                                                                        |
| DI                               | D       | Feeder Differential                                                       | Operated=1    |                 | RELAY LAN |                                                                                                                        |
| DI                               | D       | Transformer Trouble                                                       | Operated=1    |                 | RELAY LAN | 63TX, 51G, 64R                                                                                                         |
| DI                               | D       | Trafo Trouble Alarm (Buch., OTI, WTI)                                     | Operated=1    |                 | RELAY LAN |                                                                                                                        |
| DI                               | D       | Trafo Trouble Trip (Buch., OTI, WTI)                                      | Operated=1    |                 | RELAY LAN |                                                                                                                        |
| <b>VFD TIE FEEDER</b>            |         |                                                                           |               |                 |           |                                                                                                                        |
| DI                               | S       | CB in service &                                                           | Closed        | Not closed      | HARDWIRED |                                                                                                                        |
| DI                               | S       | CB in service &                                                           | Open          | Not open        | HARDWIRED |                                                                                                                        |
| DI                               | D       | Trip Circuit Supervision                                                  | Unhealthy     | Healthy         | HARDWIRED |                                                                                                                        |
| <b>MISCELLANEOUS I/O SIGNALS</b> |         |                                                                           |               |                 |           |                                                                                                                        |
| DI                               | D       | All Signals/ data related to Online temperature Monitoring System (OTMS). |               |                 | RELAY LAN | Refer to Job Specification and System Architecture Drawing for data interface related to OTMS system with owner's ECS. |

### Notes

- 1.0 Acquisition of input/output (I/O) signals as hardwired or software:
  - a) All numerical relays shall be connected to ECS-RTU. ECS shall acquire relay and metering status I/O signals of the relays. These I/O signals have been indicated as "relay and metering LAN" in the typical I/O list above.
  - b) All other I/Os shall be acquired hardwired and have been indicated as "hardwired" in the typical I/O list above. All hardwired signals shall be wired and terminated in respective panels.
  - c) In case any of these data cannot be acquired over the relay LAN, these signals have to be provided as hardwired. For requirement of numerical relays, refer Electrical part of contract document.
- 2.0 This I/O list is indicative only. Any other I/O required for meeting the contract requirements shall be identified and provided by CONTRACTOR.
- 3.0 Transformer oil temperature and transformer winding temperature shall be acquired hardwired from 66kV power transformers only. These I/Os shall be acquired as a 4-20 mA signal from the transformer.

### Guidelines for ECS I/O Interface Design

|                        |                                                                       |
|------------------------|-----------------------------------------------------------------------|
| Analogue Input Signals | Signal transducers for hard-wired analogue inputs shall have accuracy |
|------------------------|-----------------------------------------------------------------------|

|                        |                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | class 0.1 for the range 0-120%. All transducers shall be externally-powered types. External power supply shall be 230V AC UPS.                                                                                                                                                                                                                                                       |
|                        | For all measurements for I, V, MW, MVAR, Hz, obtained on the relay and metering LAN, maximum possible accuracy shall be ensured                                                                                                                                                                                                                                                      |
| Digital Input Signals  |                                                                                                                                                                                                                                                                                                                                                                                      |
| Alarm (D)              | Alarm is a signal which requires operator to be alerted such as VT circuit MCB (closed, open), relays 86 & 95 (operated, reset), auto-changeover (blocked, not blocked), DC control supply (healthy, failed), line voltage (unhealthy, healthy), bus voltage (unhealthy, healthy), motor trip from process, under-voltage trip. This shall be hardwired / on relay LAN as specified. |
|                        | For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) preferred. CONTRACTOR shall specifically indicate if NC contact is being provided in place of NO contact.                                                                                                                                                                       |
|                        | Generally a hardwired alarm point is put under "sequence of event" monitoring                                                                                                                                                                                                                                                                                                        |
| Status (S)             | For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) required                                                                                                                                                                                                                                                                        |
| Digital Output Signals |                                                                                                                                                                                                                                                                                                                                                                                      |
| Command (C)            | Hardwired through potential free changeover type contact of interposing relay, contact rating 5 A, 240 V AC and/or 4 A, 110V DC. Coil rating shall be 24 V DC                                                                                                                                                                                                                        |

CLIENT : INDIAN OIL CORPORATION LTD.  
PROJECT : PANIPAT REFINERY EXPANSION PROJECT (P-25)  
EIL JOB NO. : B269  
DISCIPLINE : ELECTRICAL  
MR NO. : B269-999-XI-MR-0440

| D       | 01-04-2022 | ISSUED WITH TENDER | MKM         | RG       | HK       |
|---------|------------|--------------------|-------------|----------|----------|
| REV. NO | DATE       | PURPOSE            | PREPARED BY | REVIEWER | APPROVER |

**PREAMBLE TO VENDOR LIST**

1. OWNER/EIL approved vendor list for Electrical items is enclosed in this section. VENDOR shall necessarily procure all the material/equipment forming permanent part of the unit/plant from OWNER/EIL approved vendor only. This shall include sub ordered items/components also. The "Approved Vendors" shall be item specific.
2. VENDOR may procure material from any of OWNER/EIL approved vendors. However current validity of vendor approval & their approved product range and the conditions imposed while according vendor approval as per EIL enlistment letter shall be verified by the VENDOR before placement of order.
  - VENDOR shall also verify the work load, stability and solvency status of the vendor prior to placement of order.
  - Vendors on OWNER/EIL holiday list shall not be considered for ordering, which need to be verified by the VENDOR prior to placement of order. VENDOR shall comply with this requirement without any time or cost implication to Owner.
  - In case any vendor is registered with EIL as an approved vendor subsequent to release of this vendor list, the same may also be considered by the VENDOR with prior intimation to OWNER/EIL and obtain their concurrence prior to placement of order.
  - Wherever job specification calls for requisite proven track record, the same shall be complied and necessary documents to be submitted for EIL/Client/Licenser approval prior to ordering.
3. Compliance to procurement of material from approved vendors is mandatory and shall be fully complied. No deviation to approved vendor list shall generally be acceptable.
4. For items not covered in the above list, the vendor list shall be approved by OWNER/EIL prior to placement of order by VENDOR. VENDOR shall list down the proposed suppliers/vendors for such items and submit the same for OWNER/EIL's review/approval along with necessary documents/credentials. Non-acceptance of a particular proposed vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication.
5. VENDOR shall have an independent assessment of capability of all the vendors for timely deliveries of material/equipment. Any delays in deliveries by vendor(s) shall not be a cause of schedule and cost implication.
6. At any stage of the project, if it comes to the notice of OWNER/EIL that VENDOR has procured material/equipment, intentionally or unintentionally whatsoever, from an unapproved vendor and/or items not falling in approved product range of vendor(s), then the same shall be rejected forthwith and VENDOR shall be liable to replace such material/plant/machinery within the contract price and without any time/schedule implication.
7. Vendor may procure material from any of owners approved vendors. However current validity & range of approval as per enlistment letter, workload, stability & solvency need to be verified by vendor before placement of order.
8. For all equipment and components listed other than above, vendor shall submit past track record for the proposed sub vendors & obtain written approval from EIL/IOCL before placing order.
9. Make of equipment/component of foreign origin other than listed above shall be subject to EIL/IOCL review during detail engineering based on PTR to be submitted by vendor.

| Sr No              | Supplier Code | Supplier Name                                       | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------------------|---------|---------------------|
| Item Code : 06AA   |               | Description : HVAC SYSTEM- CENTRAL AIR CONDITIONING |         |                     |
| Approved Suppliers |               |                                                     |         |                     |
| 1                  | E178          | VERTIV ENERGY PRIVATE LIMITED                       | INDIA   |                     |
| 2                  | A336          | ADVANCE VENTILATION PVT. LTD                        | INDIA   |                     |
| 3                  | 3678          | ROOTS COOLING SYSTEMS PVT. LTD.                     | INDIA   |                     |
| 4                  | B029          | BLUE STAR LTD                                       | INDIA   |                     |
| 5                  | 3962          | ANEMO PROJECTS PVT LTD                              | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                        | Country | Holiday Description |
|--------------------|---------------|------------------------------------------------------|---------|---------------------|
| Item Code : 06AB   |               | Description : HVAC SYSTEM- PACKAGED AIR CONDITIONING |         |                     |
| Approved Suppliers |               |                                                      |         |                     |
| 1                  | B029          | BLUE STAR LTD                                        | INDIA   |                     |
| 2                  | E178          | VERTIV ENERGY PRIVATE LIMITED                        | INDIA   |                     |
| 3                  | 3886          | PURVI ENGINEERS INDIA PVT LTD                        | INDIA   |                     |
| 4                  | A336          | ADVANCE VENTILATION PVT. LTD                         | INDIA   |                     |
| 5                  | A381          | AIR PERFECTION                                       | INDIA   |                     |
| 6                  | 3678          | ROOTS COOLING SYSTEMS PVT. LTD.                      | INDIA   |                     |
| 7                  | S461          | S K SYSTEMS PVT LTD                                  | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                       | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------------------|---------|---------------------|
| Item Code : 07AC   |               | Description : CRANE- E.O.T (SAFE AREA)              |         |                     |
| Approved Suppliers |               |                                                     |         |                     |
| 1                  | 3875          | MEEKA MACHINERY PVT LTD                             | INDIA   |                     |
| 2                  | S377          | SAFEX ELECTROMECH PVT LTD                           | INDIA   |                     |
| 3                  | M248          | MEEKA MACHINERY PVT LTD                             | INDIA   |                     |
| 4                  | F023          | FURNACE AND FOUNDRY EQUIPMENT CO.                   | INDIA   |                     |
| 5                  | C035          | CONSOLIDATED HOISTS PVT LTD.                        | INDIA   |                     |
| 6                  | E227          | ELECTROMECH MATERIAL HANDLING SYSTEMS (I) PVT. LTD. | INDIA   |                     |
| 7                  | W013          | WMI KONECRANES INDIA LTD.                           | INDIA   |                     |
| 8                  | S853          | STAHL CRANE SYSTEMS GMBH                            | GERMANY |                     |
| 9                  | A266          | ANUPAM INDUSTRIES LIMITED (ANAND)                   | INDIA   |                     |
| 10                 | H012          | HEAVY ENGINEERING CORPORATION LTD                   | INDIA   |                     |
| 11                 | T222          | TATA STEEL GROWTH SHOP                              | INDIA   |                     |
| 12                 | G183          | GRIP ENGINEERS PVT.LTD                              | INDIA   |                     |
| 13                 | W005          | BRADY & MORRIS ENGINEERING CO. LTD.                 | INDIA   |                     |
| 14                 | 3620          | TECHNO INDUSTRIES                                   | INDIA   |                     |
| 15                 | E072          | EDDY CRANES ENGRS (P) LTD                           | INDIA   |                     |
| 16                 | S138          | SAFEX ENERGY PVT LTD                                | INDIA   |                     |
| 17                 | 3622          | UNIQUE INDUSTRIAL HANDLERS PVT. LTD.                | INDIA   |                     |
| 18                 | 3619          | TECHNO INDUSTRIES                                   | INDIA   |                     |

| Sr No              | Supplier Code | Supplier Name                       | Country | Holiday Description |
|--------------------|---------------|-------------------------------------|---------|---------------------|
| Item Code : 07AH   |               | Description : CHAIN PULLEY BLOCK    |         |                     |
| Approved Suppliers |               |                                     |         |                     |
| 1                  | W005          | BRADY & MORRIS ENGINEERING CO. LTD. | INDIA   |                     |
| 2                  | H129          | HERCULES HOISTS LTD                 | INDIA   |                     |
| 3                  | 3921          | BAKELITE ELECTRICAL MFG CO.PVT LTD  | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                         | Country  | Holiday Description |
|--------------------|---------------|-------------------------------------------------------|----------|---------------------|
| Item Code : 13BA   |               | Description : SWITCHBOARD-HV (INDOOR) WITH VCB BREAKR |          |                     |
| Approved Suppliers |               |                                                       |          |                     |
| 1                  | A309          | ABB INDIA LTD (NASIK)                                 | INDIA    |                     |
| 2                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED              | INDIA    |                     |
| 3                  | L088          | LARSEN & TOUBRO LTD- TAMCO DIV.                       | MALAYSIA |                     |
| 4                  | C010          | CG POWER AND INDUSTRIAL SOLUTIONS LIMITED             | INDIA    |                     |
| 5                  | B041A         | BHEL (BHOPAL)                                         | INDIA    |                     |
| 6                  | S109          | SCHNEIDER ELECTRIC INFRA. LTD(FORM A347)              | INDIA    |                     |
| 7                  | S003          | SIEMENS LIMITED                                       | INDIA    |                     |
| 8                  | 3670          | STELMEC LIMITED                                       | INDIA    |                     |
| 9                  | 3856          | SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED             | INDIA    |                     |



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| Sr No              | Supplier Code | Supplier Name                                       | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------------------|---------|---------------------|
| Item Code : 13BC   |               | Description : SWITCHBOARD-M.V.-MCC/PCC/PMCC-DRAWOUT |         |                     |
| Approved Suppliers |               |                                                     |         |                     |
| 1                  | C024          | CONTROLS & SCHEMATICS LTD                           | INDIA   |                     |
| 2                  | L001C         | LARSEN & TOUBRO LTD-POWAI                           | INDIA   |                     |
| 3                  | 3873          | ABB INDIA LTD                                       | INDIA   |                     |
| 4                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED            | INDIA   |                     |
| 5                  | S109          | SCHNEIDER ELECTRIC INFRA. LTD(FORM A347)            | INDIA   |                     |
| 6                  | S003          | SIEMENS LIMITED                                     | INDIA   |                     |
| 7                  | L063          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED            | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                            | Country | Holiday Description |
|--------------------|---------------|------------------------------------------|---------|---------------------|
| Item Code : 13BD   |               | Description : RELAY & CONTROL PANEL      |         |                     |
| Approved Suppliers |               |                                          |         |                     |
| 1                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED | INDIA   |                     |
| 2                  | S003B         | SIEMENS LTD - GOA                        | INDIA   |                     |
| 3                  | 3919          | VENSON ELECTRIC PRIVATE LIMITED          | INDIA   |                     |
| 4                  | E143          | EASUN REYROLLE LTD                       | INDIA   |                     |
| 5                  | G147          | GE INDIA INDUSTRIAL PVT LTD              | INDIA   |                     |
| 6                  | E156          | ENPRO INDUSTRIAL AUTOMATION PVT LTD      | INDIA   |                     |
| 7                  | D153          | DANISH PRIVATE LIMITED                   | INDIA   |                     |
| 8                  | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 9                  | A392          | GE T&D INDIA LIMITED                     | INDIA   |                     |
| 10                 | 3860          | HITACHI ENERGY INDIA LIMITED             | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                              | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------|---------|---------------------|
| Item Code : 13BE   |               | Description : SWITCHBOARD-HV-GAS INSULATED |         |                     |
| Approved Suppliers |               |                                            |         |                     |
| 1                  | S109          | SCHNEIDER ELECTRIC INFRA. LTD(FORM A347)   | INDIA   |                     |
| 2                  | A309          | ABB INDIA LTD (NASIK)                      | INDIA   |                     |
| 3                  | S003B         | SIEMENS LTD - GOA                          | INDIA   |                     |
| 4                  | A070          | ABB INDIA LTD (BARODA)                     | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                       | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------------------|---------|---------------------|
| Item Code : 13BF   |               | Description : SWITCHBOARD FIXED FOR PACKAGE EQUIPTS |         |                     |
| Approved Suppliers |               |                                                     |         |                     |
| 1                  | V124          | VIDHYUT CONTROL (INDIA) PVT LTD                     | INDIA   |                     |
| 2                  | 3837          | MILESTONES SWITCHGEARS PVT LTD                      | INDIA   |                     |
| 3                  | M264          | MAKTEL SYSTEMS                                      | INDIA   |                     |
| 4                  | A212          | ACCUSONIC CONTROLS PVT LTD                          | INDIA   |                     |
| 5                  | M138          | M.K. ENGINEERS & CONTROLS PVT. LTD.                 | INDIA   |                     |
| 6                  | T114          | TRICOLITE ELECTRICAL INDUSTRIES PVT LTD             | INDIA   |                     |
| 7                  | 4007          | INTRELEC                                            | INDIA   |                     |
| 8                  | N148          | NITYA ELECTROCONTROLS PRIVATE LIMITED               | INDIA   |                     |
| 9                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED            | INDIA   |                     |
| 10                 | E209          | ELECTRO ALLIED PRODUCTS                             | INDIA   |                     |
| 11                 | 3780          | POSITRONICS PVT LTD                                 | INDIA   |                     |
| 12                 | Z011          | ZENITH ENGINEERING CORP.                            | INDIA   |                     |
| 13                 | P289          | POPULAR SWITCHGEARS PVT LTD                         | INDIA   |                     |

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| Sr No              | Supplier Code | Supplier Name                                         | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------------------|---------|---------------------|
| Item Code : 13GA   |               | Description : CONTROL STATIONS- WEATHERPROOF          |         |                     |
| Approved Suppliers |               |                                                       |         |                     |
| 1                  | F165          | FCG FLAMPROOF CONTROL GEARS P. LTD(C-157              | INDIA   |                     |
| 2                  | B002          | BCH ELECTRIC LTD                                      | INDIA   |                     |
| 3                  | E111          | ELECTRICAL EQUIPMENT CORPORATION                      | INDIA   |                     |
| 4                  | 3681          | FCG POWER INDUSTRIES PVT LTD                          | INDIA   |                     |
| 5                  | F141          | FCG POWER INDUSTRIES PVT LTD                          | INDIA   |                     |
| 6                  | B024          | BALIGA LIGHTING EQUIPMENTS (P) LIMITED                | INDIA   |                     |
| 7                  | F036          | FLAMEPROOF EQUIPMENTS PVT.LTD                         | INDIA   |                     |
| 8                  | G159          | PEPPERL & FUCHS MANUFACTURING (INDIA) PRIVATE LIMITED | INDIA   |                     |
| 9                  | T166          | TEKNIC ELECTRIC (I) PVT. LTD.                         | INDIA   |                     |
| 10                 | F024          | FLEXPRO ELECTRICALS PVT LTD                           | INDIA   |                     |
| 11                 | E024          | EX-PROTECTA                                           | INDIA   |                     |
| 12                 | S158          | SUDHIR SWITCHGEARS PVT LTD                            | INDIA   |                     |
| 13                 | 3706          | PHOENIX MECANO INDIA PVT. LTD.                        | INDIA   |                     |

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| Sr No              | Supplier Code | Supplier Name                                    | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------------|---------|---------------------|
| Item Code : 13HB   |               | Description : BATTERY CHARGERS                   |         |                     |
| Approved Suppliers |               |                                                  |         |                     |
| 1                  | D120          | DUBAS ENGINEERING PVT LTD                        | INDIA   |                     |
| 2                  | 3861          | STATCON ENERGIAA PVT. LTD.                       | INDIA   |                     |
| 3                  | M225          | MASS-TECH CONTROLS PVT LTD                       | INDIA   |                     |
| 4                  | C043          | CHHABI ELECTRICALS PVT LIMITED                   | INDIA   |                     |
| 5                  | A267          | AMARA RAJA POWER SYSTEMS LIMITED                 | INDIA   |                     |
| 6                  | H010A         | HITACHI HI-REL POWER ELECTRONICS PRIVATE LIMITED | INDIA   |                     |
| 7                  | U021          | UNIVERSAL INSTRUMENT MFG CO PVT LTD              | INDIA   |                     |
| 8                  | 27401         | Borri S.p.A                                      | ITALY   |                     |
| 9                  | H132          | HBL POWER SYSTEMS LTD                            | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                          | Country | Holiday Description |
|--------------------|---------------|----------------------------------------|---------|---------------------|
| Item Code : 13HD   |               | Description : BATTERIES-NICKLE CADMIUM |         |                     |
| Approved Suppliers |               |                                        |         |                     |
| 1                  | A305          | SAFT INDIA PRIVATE LIMITED             | INDIA   |                     |
| 2                  | H132          | HBL POWER SYSTEMS LTD                  | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                    | Country     | Holiday Description |
|--------------------|---------------|--------------------------------------------------|-------------|---------------------|
| Item Code : 13IA   |               | Description : U.P.S.SYSTEM                       |             |                     |
| Approved Suppliers |               |                                                  |             |                     |
| 1                  | 27401         | Borri S.p.A                                      | ITALY       |                     |
| 2                  | T597          | TOSHIBA CORPORATION                              | JAPAN       |                     |
| 3                  | C592          | CHLORIDE INDUSTRIAL SYSTEMS                      | FRANCE      |                     |
| 4                  | D026          | VERTIV ENERGY PVT. LTD.                          | INDIA       |                     |
| 5                  | H010A         | HITACHI HI-REL POWER ELECTRONICS PRIVATE LIMITED | INDIA       |                     |
| 6                  | G562          | GUTOR ELECTRONIC LLC                             | SWITZERLAND |                     |



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| Sr No              | Supplier Code | Supplier Name                                          | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------------------|---------|---------------------|
| Item Code : 13JD   |               | Description : MOTOR INDUCTION-MV (INDL.TYPE SAFE AREA) |         |                     |
| Approved Suppliers |               |                                                        |         |                     |
| 1                  | M282          | MARATHON ELECTRIC MOTORS (INDIA) LTD.                  | INDIA   |                     |
| 2                  | B048          | BHARAT BIJLEE LIMITED                                  | INDIA   |                     |
| 3                  | 3668          | CG POWER & INDUSTRIAL SOLUTIONS LTD.                   | INDIA   |                     |
| 4                  | A310          | ABB INDIA LTD-FARIDABAD                                | INDIA   |                     |
| 5                  | L065          | LAXMI HYDRAULICS PVT LTD                               | INDIA   |                     |
| 6                  | A200          | ABB INDIA LTD (BANGALORE)                              | INDIA   |                     |
| 7                  | 3940          | HEM INDUSTRIES                                         | INDIA   |                     |
| 8                  | 3986          | HAVELLS INDIA LTD                                      | INDIA   |                     |
| 9                  | S003          | SIEMENS LIMITED                                        | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                            | Country                                      | Holiday Description |
|--------------------|---------------|------------------------------------------|----------------------------------------------|---------------------|
| Item Code : 13JK   |               | Description : MOTORS - IMPORTED          |                                              |                     |
| Approved Suppliers |               |                                          |                                              |                     |
| 1                  | J511          | JEUMONT SA / FRAMATONE ANP               | FRANCE                                       |                     |
| 2                  | C730          | GE ENERGY POWER CONVERSION FRANCE SAS    | FRANCE                                       |                     |
| 3                  | L575          | LOHER GMBH                               | GERMANY                                      |                     |
| 4                  | L603          | LLOYD DYNAMOWERKE GMBH & CO. KG          | GERMANY                                      |                     |
| 5                  | W598          | WEG EQUIPAMENTOS ELETRICOS S.A.          | BRAZIL                                       |                     |
| 6                  | G632          | GENERAL ELECTRIC CANADA                  | CANADA                                       |                     |
| 7                  | A717          | NIDEC ASI SPA                            | ITALY                                        |                     |
| 8                  | W598A         | WEGEURO - INDUSTRIA ELECTRICA S.A.       | PORTUGAL                                     |                     |
| 9                  | H641          | HYUNDAI HEAVY INDUSTRIES CO. LTD         | KOREA, PEOPLE'S<br>DEMOCRATIC<br>REPUBLIC OF |                     |
| 10                 | H510          | HITACHI LTD                              | JAPAN                                        |                     |
| 11                 | 27420         | TOSHIBA MITSUBISHI ELEC. IND. SYS. CORP. | JAPAN                                        |                     |
| 12                 | T597          | TOSHIBA CORPORATION                      | JAPAN                                        |                     |
| 13                 | C736          | CEMP SRL                                 | ITALY                                        |                     |
| 14                 | A661          | ASEA BROWN BOVERY LTD (ABB LTD)          | SWITZERLAND                                  |                     |

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| Sr No              | Supplier Code | Supplier Name                               | Country | Holiday Description |
|--------------------|---------------|---------------------------------------------|---------|---------------------|
| Item Code : 13KA   |               | Description : TRANSFORMERS-POWER-ABOVE 5MVA |         |                     |
| Approved Suppliers |               |                                             |         |                     |
| 1                  | 3713          | CG POWER & INDUSTRIAL SOLUTIONS LTD.        | INDIA   |                     |
| 2                  | T129          | TRANSFORMERS & RECTIFIERS (I) LTD           | INDIA   |                     |
| 3                  | B048          | BHARAT BIJLEE LIMITED                       | INDIA   |                     |
| 4                  | S109          | SCHNEIDER ELECTRIC INFRA. LTD(FORM A347)    | INDIA   |                     |
| 5                  | 3929          | ATLANTA ELECTRICALS PRIVATE LIMITED         | INDIA   |                     |
| 6                  | 3692          | KANOHAR ELECTRICALS LIMITED                 | INDIA   |                     |
| 7                  | B184          | BHEL JHANSI                                 | INDIA   |                     |
| 8                  | 3684          | VOLTAMP TRANSFORMERS LTD                    | INDIA   |                     |
| 9                  | K107          | KANOHAR ELECTRICALS LTD.                    | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                      | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------------|---------|---------------------|
| Item Code : 13KB   |               | Description : TRANSFORMERS-DISTRIBUTION-UP TO 5MVA |         |                     |
| Approved Suppliers |               |                                                    |         |                     |
| 1                  | 3692          | KANO HAR ELECTRICALS LIMITED                       | INDIA   |                     |
| 2                  | 3812          | TRANSFORMERS & RECTIFIERS (I) LTD                  | INDIA   |                     |
| 3                  | V003          | VOLTAMP TRANSFORMERS LTD                           | INDIA   |                     |
| 4                  | 3659          | CG POWER & INDUSTRIAL SOLUTIONS LTD.               | INDIA   |                     |
| 5                  | R191          | RAYCHEM RPG PRIVATE LIMITED                        | INDIA   |                     |
| 6                  | K107          | KANO HAR ELECTRICALS LTD.                          | INDIA   |                     |
| 7                  | S109          | SCHNEIDER ELECTRIC INFRA. LTD(FORM A347)           | INDIA   |                     |
| 8                  | P292          | HAMMOND POWER SOLUTIONS PRIVATE LIMITED            | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                           | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------|---------|---------------------|
| Item Code : 13LD   |               | Description : HIGH MAST LIGHTING SYSTEM |         |                     |
| Approved Suppliers |               |                                         |         |                     |
| 1                  | 3850          | BAJAJ ELECTRICALS LTD                   | INDIA   |                     |
| 2                  | B011          | BAJAJ ELECTRICALS LTD                   | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                          | Country | Holiday Description |
|--------------------|---------------|----------------------------------------|---------|---------------------|
| Item Code : 130A   |               | Description : CABLES-HIGH VOLTAGE-XLPE |         |                     |
| Approved Suppliers |               |                                        |         |                     |
| 1                  | H060          | HAVELLS INDIA LTD                      | INDIA   |                     |
| 2                  | P254          | POLYCAB INDIA LIMITED                  | INDIA   |                     |
| 3                  | 3770          | CMI LIMITED                            | INDIA   |                     |
| 4                  | K190A         | KEC INTERNATIONAL LIMITED              | INDIA   |                     |
| 5                  | S147          | STERLITE POWER TRANSMISSION LIMITED    | INDIA   |                     |
| 6                  | 3723          | POLYCAB INDIA LIMITED                  | INDIA   |                     |
| 7                  | 3763          | GEMSCAB INDUSTRIES LTD                 | INDIA   |                     |
| 8                  | 3959          | TIRUPATI PLASTOMATICS PVT. LTD.        | INDIA   |                     |
| 9                  | 3647          | GUPTA POWER INFRASTRUCTURE LIMITED     | INDIA   |                     |
| 10                 | 3669          | KEI INDUSTRIES LIMITED                 | INDIA   |                     |
| 11                 | K082          | KEI INDUSTRIES LIMITED                 | INDIA   |                     |
| 12                 | U085          | APAR INDUSTRIES LTD                    | INDIA   |                     |
| 13                 | U003          | UNIVERSAL CABLES LTD                   | INDIA   |                     |

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| Sr No              | Supplier Code | Supplier Name                                      | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------------|---------|---------------------|
| Item Code : 13OC   |               | Description : CABLES-MEDIUM VOLTAGE-POWER-PVC/XLPE |         |                     |
| Approved Suppliers |               |                                                    |         |                     |
| 1                  | U085          | APAR INDUSTRIES LTD                                | INDIA   |                     |
| 2                  | 3732          | POLYCAB INDIA LIMITED                              | INDIA   |                     |
| 3                  | 4001          | RAVI INDUSTRIES                                    | INDIA   |                     |
| 4                  | G156          | GEMSCAB INDUSTRIES LTD                             | INDIA   |                     |
| 5                  | 3969          | SHIVPRIYA CABLES PRIVATE LIMITED                   | INDIA   |                     |
| 6                  | 3796          | PARAMOUNT COMMUNICATIONS LTD                       | INDIA   |                     |
| 7                  | K082          | KEI INDUSTRIES LIMITED                             | INDIA   |                     |
| 8                  | 3765          | THERMO CABLES LTD.                                 | INDIA   |                     |
| 9                  | C145          | CORDS CABLE INDUSTRIES LTD                         | INDIA   |                     |
| 10                 | A132          | ASSOCIATED FLEXIBLES & WIRES [P] LTD               | INDIA   |                     |
| 11                 | 3783          | POLYCAB INDIA LIMITED                              | INDIA   |                     |
| 12                 | 3722          | POLYCAB INDIA LIMITED                              | INDIA   |                     |
| 13                 | K190A         | KEC INTERNATIONAL LIMITED                          | INDIA   |                     |
| 14                 | H060          | HAVELLS INDIA LTD                                  | INDIA   |                     |
| 15                 | 3781          | POLYCAB INDIA LIMITED                              | INDIA   |                     |
| 16                 | 3647          | GUPTA POWER INFRASTRUCTURE LIMITED                 | INDIA   |                     |
| 17                 | 3669          | KEI INDUSTRIES LIMITED                             | INDIA   |                     |
| 18                 | 3602          | Special Cables Pvt. Ltd.                           | INDIA   |                     |
| 19                 | S304          | SUYOG ELECTRICALS LTD                              | INDIA   |                     |
| 20                 | 3731          | POLYCAB INDIA LIMITED                              | INDIA   |                     |
| 21                 | U003          | UNIVERSAL CABLES LTD                               | INDIA   |                     |
| 22                 | S025          | SRIRAM CABLES PVT LTD                              | INDIA   |                     |
| 23                 | 3854          | CHANDRESH CABLES LIMITED                           | INDIA   |                     |
| 24                 | 3770          | CMI LIMITED                                        | INDIA   |                     |



| Sr No              | Supplier Code | Supplier Name                                    | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------------|---------|---------------------|
| Item Code : 130D   |               | Description : CABLES:CONTROL (UNPAIRED)-PVC/XLPE |         |                     |
| Approved Suppliers |               |                                                  |         |                     |
| 1                  | 3784          | POLYCAB INDIA LIMITED                            | INDIA   |                     |
| 2                  | U003          | UNIVERSAL CABLES LTD                             | INDIA   |                     |
| 3                  | 3722          | POLYCAB INDIA LIMITED                            | INDIA   |                     |
| 4                  | G156          | GEMSCAB INDUSTRIES LTD                           | INDIA   |                     |
| 5                  | 3724          | CORDS CABLE INDUSTRIESLTD.                       | INDIA   |                     |
| 6                  | C145          | CORDS CABLE INDUSTRIES LTD                       | INDIA   |                     |
| 7                  | 3814          | RR KABEL LIMITED                                 | INDIA   |                     |
| 8                  | H060          | HAVELLS INDIA LTD                                | INDIA   |                     |
| 9                  | C019          | CMI LIMITED                                      | INDIA   |                     |
| 10                 | D012          | DELTON CABLES LIMITED                            | INDIA   |                     |
| 11                 | E063          | ELKAY TELELINKS LTD.-                            | INDIA   |                     |
| 12                 | K082          | KEI INDUSTRIES LIMITED                           | INDIA   |                     |
| 13                 | 3854          | CHANDRESH CABLES LIMITED                         | INDIA   |                     |
| 14                 | 3872          | GUPTA POWER INFRASTRUCTURE LIMITED               | INDIA   |                     |
| 15                 | K190A         | KEC INTERNATIONAL LIMITED                        | INDIA   |                     |
| 16                 | 3752          | APAR INDUSTRIES LTD                              | INDIA   |                     |
| 17                 | T212          | THERMO CABLES LTD (FORM. T-150)                  | INDIA   |                     |
| 18                 | 3796          | PARAMOUNT COMMUNICATIONS LTD                     | INDIA   |                     |
| 19                 | S304          | SUYOG ELECTRICALS LTD                            | INDIA   |                     |
| 20                 | 3602          | Special Cables Pvt. Ltd.                         | INDIA   |                     |
| 21                 | S025          | SRIRAM CABLES PVT LTD                            | INDIA   |                     |
| 22                 | A034          | ASSOCIATED CABLES PVT LTD                        | INDIA   |                     |
| 23                 | 3969          | SHIVPRIYA CABLES PRIVATE LIMITED                 | INDIA   |                     |
| 24                 | 3669          | KEI INDUSTRIES LIMITED                           | INDIA   |                     |
| 25                 | 3765          | THERMO CABLES LTD.                               | INDIA   |                     |
| 26                 | A132          | ASSOCIATED FLEXIBLES & WIRES [P] LTD             | INDIA   |                     |
| 27                 | 3783          | POLYCAB INDIA LIMITED                            | INDIA   |                     |
| 28                 | 4001          | RAVI INDUSTRIES                                  | INDIA   |                     |

| Sr No              | Supplier Code | Supplier Name                                                     | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------------------------------|---------|---------------------|
| Item Code : 13OE   |               | Description : CABLES-FIRE ALARM, COMMUNICATION AND CONTROL PAIRED |         |                     |
| Approved Suppliers |               |                                                                   |         |                     |
| 1                  | K082          | KEI INDUSTRIES LIMITED                                            | INDIA   |                     |
| 2                  | C019          | CMI LIMITED                                                       | INDIA   |                     |
| 3                  | D012          | DELTON CABLES LIMITED                                             | INDIA   |                     |
| 4                  | 3669          | KEI INDUSTRIES LIMITED                                            | INDIA   |                     |
| 5                  | S304          | SUYOG ELECTRICALS LTD                                             | INDIA   |                     |
| 6                  | U015          | UDEY PYROCABLES PVT. LTD.                                         | INDIA   |                     |
| 7                  | C145          | CORDS CABLE INDUSTRIES LTD                                        | INDIA   |                     |
| 8                  | E063          | ELKAY TELELINKS LTD.-                                             | INDIA   |                     |
| 9                  | T212          | THERMO CABLES LTD (FORM. T-150)                                   | INDIA   |                     |
| 10                 | 3724          | CORDS CABLE INDUSTRIESLTD.                                        | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                             | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------|---------|---------------------|
| Item Code : 13OH   |               | Description : CABLES - EXTRA HIGH VOLTAGE |         |                     |
| Approved Suppliers |               |                                           |         |                     |
| 1                  | S147          | STERLITE POWER TRANSMISSION LIMITED       | INDIA   |                     |
| 2                  | H060          | HAVELLS INDIA LTD                         | INDIA   |                     |
| 3                  | U003          | UNIVERSAL CABLES LTD                      | INDIA   |                     |
| 4                  | K082          | KEI INDUSTRIES LIMITED                    | INDIA   |                     |
| 5                  | 3885          | LS CABLE INDIA PRIVATE LIMITED            | INDIA   |                     |
| 6                  | 3974          | FINOLEX J-POWER SYSTEMS PVT. LTD.         | INDIA   |                     |
| 7                  | K190A         | KEC INTERNATIONAL LIMITED                 | INDIA   |                     |
| 8                  | 3723          | POLYCAB INDIA LIMITED                     | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                         | Country | Holiday Description |
|--------------------|---------------|---------------------------------------|---------|---------------------|
| Item Code : 13PA   |               | Description : CAPACITORS-HIGH VOLTAGE |         |                     |
| Approved Suppliers |               |                                       |         |                     |
| 1                  | B041A         | BHEL (BHOPAL)                         | INDIA   |                     |
| 2                  | 3860          | HITACHI ENERGY INDIA LIMITED          | INDIA   |                     |
| 3                  | 3898          | TDK INDIA PRIVATE LIMITED             | INDIA   |                     |
| 4                  | U003          | UNIVERSAL CABLES LTD                  | INDIA   |                     |



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



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| Sr No              | Supplier Code | Supplier Name                | Country | Holiday Description |
|--------------------|---------------|------------------------------|---------|---------------------|
| Item Code : 14AB   |               | Description : AUX. RELAYS    |         |                     |
| Approved Suppliers |               |                              |         |                     |
| 1                  | 3642          | M/S JVS ELECTRONICS PVT LTD  | INDIA   |                     |
| 2                  | 3860          | HITACHI ENERGY INDIA LIMITED | INDIA   |                     |
| 3                  | A392          | GE T&D INDIA LIMITED         | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                            | Country | Holiday Description |
|--------------------|---------------|------------------------------------------|---------|---------------------|
| Item Code : 14BA   |               | Description : BIMETAL RELAYS             |         |                     |
| Approved Suppliers |               |                                          |         |                     |
| 1                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED | INDIA   |                     |
| 2                  | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD | INDIA   |                     |
| 3                  | A200          | ABB INDIA LTD (BANGALORE)                | INDIA   |                     |
| 4                  | B002          | BCH ELECTRIC LTD                         | INDIA   |                     |
| 5                  | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 6                  | G147          | GE INDIA INDUSTRIAL PVT LTD              | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                         | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------------------|---------|---------------------|
| Item Code : 14BB   |               | Description : BUS DUCTS (M.V)                         |         |                     |
| Approved Suppliers |               |                                                       |         |                     |
| 1                  | E107          | ENPRO ENGINEERING                                     | INDIA   |                     |
| 2                  | G010          | GLOBE ELECTRICAL INDUSTRIES                           | INDIA   |                     |
| 3                  | B222          | GODREJ & BOYCE MANUFACTURING COMPANY LIMITED          | INDIA   |                     |
| 4                  | N132          | NARMADA SWITCHGEAR PVT. LTD                           | INDIA   |                     |
| 5                  | N148          | NITYA ELECTROCONTROLS PRIVATE LIMITED                 | INDIA   |                     |
| 6                  | K191          | Stardrive Busducts Limited                            | INDIA   |                     |
| 7                  | M138          | M.K. ENGINEERS & CONTROLS PVT. LTD.                   | INDIA   |                     |
| 8                  | J096          | JASPER ENGINEERS PVT LTD                              | INDIA   |                     |
| 9                  | U036          | UNITED ELECTRIC CO (DELHI) PVT LTD                    | INDIA   |                     |
| 10                 | 3954          | GODREJ & BOYCE MANUFACTURING COMPANY LIMITED          | INDIA   |                     |
| 11                 | A402          | Novateur Electrical & Digital Systems Private Limited | INDIA   |                     |

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| Sr No              | Supplier Code | Supplier Name                                | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------|---------|---------------------|
| Item Code : 14BC   |               | Description : BUS DUCT (H.V)                 |         |                     |
| Approved Suppliers |               |                                              |         |                     |
| 1                  | B184          | BHEL JHANSI                                  | INDIA   |                     |
| 2                  | 3954          | GODREJ & BOYCE MANUFACTURING COMPANY LIMITED | INDIA   |                     |
| 3                  | B222          | GODREJ & BOYCE MANUFACTURING COMPANY LIMITED | INDIA   |                     |
| 4                  | U036          | UNITED ELECTRIC CO (DELHI) PVT LTD           | INDIA   |                     |
| 5                  | K191          | Stardrive Busducts Limited                   | INDIA   |                     |
| 6                  | N132          | NARMADA SWITCHGEAR PVT. LTD                  | INDIA   |                     |
| 7                  | E107          | ENPRO ENGINEERING                            | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                | Country | Holiday Description |
|--------------------|---------------|------------------------------|---------|---------------------|
| Item Code : 14BD   |               | Description : BUCHHOLZ RELAY |         |                     |
| Approved Suppliers |               |                              |         |                     |
| 1                  | A319          | A J SERVICES                 | INDIA   |                     |
| 2                  | A318          | ATVUS INDUSTRIES             | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                    | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------------|---------|---------------------|
| Item Code : 14CB   |               | Description : CABLE TERMN. & JOINTING KIT        |         |                     |
| Approved Suppliers |               |                                                  |         |                     |
| 1                  | R160          | RAYCHEM RPG PRIVATE LIMITED                      | INDIA   |                     |
| 2                  | T217          | 3M ELECTRO & COMMUNICATION INDIA PRIVATE LIMITED | INDIA   |                     |
| 3                  | 3645          | YAMUNA CABLE ACCESSORIES PVT. LTD.               | INDIA   |                     |
| 4                  | H168          | HEATSHRINK TECHNOLOGIES LTD (FORM. R136)         | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                  | Country | Holiday Description |
|--------------------|---------------|------------------------------------------------|---------|---------------------|
| Item Code : 14CC   |               | Description : CIRCUIT BREAKER SF-6 OUTDOOR EHV |         |                     |
| Approved Suppliers |               |                                                |         |                     |
| 1                  | S003          | SIEMENS LIMITED                                | INDIA   |                     |
| 2                  | 3828          | GE T&D INDIA LIMITED                           | INDIA   |                     |
| 3                  | C010          | CG POWER AND INDUSTRIAL SOLUTIONS LIMITED      | INDIA   |                     |
| 4                  | 3859          | HITACHI ENERGY INDIA LIMITED                   | INDIA   |                     |
| 5                  | B041A         | BHEL (BHOPAL)                                  | INDIA   |                     |



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



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



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| Sr No              | Supplier Code | Supplier Name                                      | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------------|---------|---------------------|
| Item Code : 14CF   |               | Description : CONTROL SWITCHES / SELECTOR SWITCHES |         |                     |
| Approved Suppliers |               |                                                    |         |                     |
| 1                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED           | INDIA   |                     |
| 2                  | S003          | SIEMENS LIMITED                                    | INDIA   |                     |
| 3                  | R159          | RELIABLE ELECTRONIC COMPONENTS PVT LTD             | INDIA   |                     |
| 4                  | S373          | SWITRON DEVICES                                    | INDIA   |                     |
| 5                  | K143          | KAYCEE INDUSTRIES LTD.                             | INDIA   |                     |
| 6                  | 4002          | P.P. INDUSTRIES                                    | INDIA   |                     |
| 7                  | H142          | HOTLINE SWITCHGEAR & CONTROLS                      | INDIA   |                     |
| 8                  | A392          | GE T&D INDIA LIMITED                               | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                   | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------------|---------|---------------------|
| Item Code : 14EA   |               | Description : EARTH LEAKAGE CIRCUIT BREAKER     |         |                     |
| Approved Suppliers |               |                                                 |         |                     |
| 1                  | 3824          | HAVELLS INDIA LIMITED                           | INDIA   |                     |
| 2                  | G147          | GE INDIA INDUSTRIAL PVT LTD                     | INDIA   |                     |
| 3                  | S450          | SCHNEIDER ELECTRIC INDIA PVT LTD                | INDIA   |                     |
| 4                  | A372          | ABB INDIA LTD                                   | INDIA   |                     |
| 5                  | L071          | LEGRAND (INDIA) PVT. LTD (FORM. M-006)          | INDIA   |                     |
| 6                  | 3726          | NOVATEUR ELECTRICAL & DIGITAL SYSTEMS PVT. LTD. | INDIA   |                     |
| 7                  | S003          | SIEMENS LIMITED                                 | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                            | Country | Holiday Description |
|--------------------|---------------|------------------------------------------|---------|---------------------|
| Item Code : 14FA   |               | Description : FUSES                      |         |                     |
| Approved Suppliers |               |                                          |         |                     |
| 1                  | C194          | EATON POWER QUALITY PRIVATE LIMITED      | INDIA   |                     |
| 2                  | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 3                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED | INDIA   |                     |
| 4                  | I013          | NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P  | INDIA   |                     |
| 5                  | G147          | GE INDIA INDUSTRIAL PVT LTD              | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                            | Country | Holiday Description |
|--------------------|---------------|------------------------------------------|---------|---------------------|
| Item Code : 14HA   |               | Description : HEAVY DUTY SWITCHES        |         |                     |
| Approved Suppliers |               |                                          |         |                     |
| 1                  | S003          | SIEMENS LIMITED                          | INDIA   |                     |
| 2                  | L103          | SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                      | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------------|---------|---------------------|
| Item Code : 14IA   |               | Description : INSTRUMENT TRANSFORMERS CT & PT (MV) |         |                     |
| Approved Suppliers |               |                                                    |         |                     |
| 1                  | 3901          | NEWTEK ELECTRICALS                                 | INDIA   |                     |
| 2                  | K149          | KALPA ELEKTRIKAL PVT LTD                           | INDIA   |                     |
| 3                  | 3789          | PRAGATI ELECTRICALS PVT LTD                        | INDIA   |                     |
| 4                  | G135          | GILBERT & MAXWELL ELECTRICALS PVT LTD              | INDIA   |                     |
| 5                  | P228          | PRAGATI ELECTRICALS PVT LTD                        | INDIA   |                     |
| 6                  | N119          | NARAYAN POWERTECH PVT LTD                          | INDIA   |                     |
| 7                  | S372          | SILKAANS ELECTRICALS MFG.CO.PVT.LTD                | INDIA   |                     |
| 8                  | P237          | PRECISE ELECTRICALS                                | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                      | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------------|---------|---------------------|
| Item Code : 14IB   |               | Description : INSTRUMENT TRANSFORMERS CT & PT (HV) |         |                     |
| Approved Suppliers |               |                                                    |         |                     |
| 1                  | 3857          | SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED          | INDIA   |                     |
| 2                  | E144          | ELECTRICAL CONTROLS & SYSTEMS                      | INDIA   |                     |
| 3                  | 3859          | HITACHI ENERGY INDIA LIMITED                       | INDIA   |                     |
| 4                  | 3730          | GEMINI INSTRATECH LTD                              | INDIA   |                     |
| 5                  | P228          | PRAGATI ELECTRICALS PVT LTD                        | INDIA   |                     |
| 6                  | K013          | KAPPA ELECTRICALS                                  | INDIA   |                     |
| 7                  | K149          | KALPA ELEKTRIKAL PVT LTD                           | INDIA   |                     |
| 8                  | 3862          | STRATON ELECTRICALS PRIVATE LIMITED                | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                             | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------|---------|---------------------|
| Item Code : 14IC   |               | Description : CT/PT OUTDOOR (EHV)         |         |                     |
| Approved Suppliers |               |                                           |         |                     |
| 1                  | 3967          | ELECTRICAL CONTROLS & SYSTEMS             | INDIA   |                     |
| 2                  | 3827          | GE T&D INDIA LIMITED                      | INDIA   |                     |
| 3                  | C010          | CG POWER AND INDUSTRIAL SOLUTIONS LIMITED | INDIA   |                     |
| 4                  | 3859          | HITACHI ENERGY INDIA LIMITED              | INDIA   |                     |
| 5                  | 3788          | PRAGATI ELECTRICALS PVT LTD               | INDIA   |                     |
| 6                  | B184          | BHEL JHANSI                               | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                        | Country | Holiday Description |
|--------------------|---------------|------------------------------------------------------|---------|---------------------|
| Item Code : 14ID   |               | Description : ISOLATOR & EARTHING SWITCH OUTDOOR EHV |         |                     |
| Approved Suppliers |               |                                                      |         |                     |
| 1                  | S003          | SIEMENS LIMITED                                      | INDIA   |                     |
| 2                  | S093          | S&S POWER SWITCHGEAR LTD                             | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                          | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------------------|---------|---------------------|
| Item Code : 14IF   |               | Description : ISOLATORS/LOAD BREAK SWITCHES(HV INDOOR) |         |                     |
| Approved Suppliers |               |                                                        |         |                     |
| 1                  | S003          | SIEMENS LIMITED                                        | INDIA   |                     |
| 2                  | P302          | PANICKKER SWITCHGEAR PVT LTD(FORM D-022)               | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                             | Country | Holiday Description |
|--------------------|---------------|-------------------------------------------|---------|---------------------|
| Item Code : 14LA   |               | Description : LIGHTNING ARRESTORS         |         |                     |
| Approved Suppliers |               |                                           |         |                     |
| 1                  | C010          | CG POWER AND INDUSTRIAL SOLUTIONS LIMITED | INDIA   |                     |
| 2                  | O009          | OBLUM ELECTRICAL INDUSTRIES (P) LTD       | INDIA   |                     |
| 3                  | W035          | W.S. INSULATOR OF INDIA                   | INDIA   |                     |
| 4                  | E091          | ELPRO INTERNATIONAL LIMITED               | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                          | Country | Holiday Description |
|--------------------|---------------|--------------------------------------------------------|---------|---------------------|
| Item Code : 14LB   |               | Description : LIGHTING FIXTURE & ACCESORY-NON HZARDOUS |         |                     |
| Approved Suppliers |               |                                                        |         |                     |
| 1                  | 3993          | LIGHTING TECHNOLOGIES INDIA PRIVATE LIMITED            | INDIA   |                     |
| 2                  | 3833          | BAJAJ ELECTRICALS LTD                                  | INDIA   |                     |
| 3                  | 3687          | PYROTECH ELECTRONICS PVT. LTD. UNIT -1                 | INDIA   |                     |
| 4                  | 3834          | BAJAJ ELECTRICALS LTD                                  | INDIA   |                     |
| 5                  | 3986          | HAVELLS INDIA LTD                                      | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                     | Country | Holiday Description |
|--------------------|---------------|---------------------------------------------------|---------|---------------------|
| Item Code : 14LC   |               | Description : LIGHTING & POWER PANELS (SAFE AREA) |         |                     |
| Approved Suppliers |               |                                                   |         |                     |
| 1                  | A372          | ABB INDIA LTD                                     | INDIA   |                     |
| 2                  | I013          | NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P           | INDIA   |                     |
| 3                  | 3825          | HAVELLS INDIA LIMITED                             | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                                | Country | Holiday Description |
|--------------------|---------------|----------------------------------------------|---------|---------------------|
| Item Code : 14LD   |               | Description : DRY TYPE LIGHTING TRANSFORMERS |         |                     |
| Approved Suppliers |               |                                              |         |                     |
| 1                  | V003          | VOLTAMP TRANSFORMERS LTD                     | INDIA   |                     |
| 2                  | G179          | GUJARAT PLUG-IN DEVICES PVT LTD              | INDIA   |                     |
| 3                  | I054          | INDCOIL TRANSFORMERS PVT LTD                 | INDIA   |                     |
| 4                  | A028          | AUTOMATIC ELECTRIC LTD.                      | INDIA   |                     |



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



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



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| Sr No              | Supplier Code | Supplier Name                     | Country | Holiday Description |
|--------------------|---------------|-----------------------------------|---------|---------------------|
| Item Code : 14MC   |               | Description : METERS              |         |                     |
| Approved Suppliers |               |                                   |         |                     |
| 1                  | R042          | RISHABH INSTRUMENTS PVT LTD       | INDIA   |                     |
| 2                  | A028A         | AUTOMATIC ELECTRIC LTD.           | INDIA   |                     |
| 3                  | M239          | MECO INSTRUMENTS PVT LTD          | INDIA   |                     |
| 4                  | N130          | NIPPEN ELECTRICAL INSTRUMENTS CO. | INDIA   |                     |
| 5                  | 3901          | NEWTEK ELECTRICALS                | INDIA   |                     |
| 6                  | S141          | SECURE METERS LIMITED             | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                          | Country | Holiday Description |
|--------------------|---------------|----------------------------------------|---------|---------------------|
| Item Code : 14MD   |               | Description : MAGNETIC OIL LEVEL GAUGE |         |                     |
| Approved Suppliers |               |                                        |         |                     |
| 1                  | I179          | INSTRUMENT & CONTROLS                  | INDIA   |                     |
| 2                  | S437          | SUKRUT UDYOG                           | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                           | Country | Holiday Description |
|--------------------|---------------|-----------------------------------------|---------|---------------------|
| Item Code : 140A   |               | Description : OIL TEMPERATURE INDICATOR |         |                     |
| Approved Suppliers |               |                                         |         |                     |
| 1                  | P269          | PRECIMEASURE CONTROLS PVT.LTD.          | INDIA   |                     |
| 2                  | P270          | PERFECT CONTROLS                        | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                     | Country | Holiday Description |
|--------------------|---------------|-----------------------------------|---------|---------------------|
| Item Code : 14OB   |               | Description : ON LOAD TAP CHANGER |         |                     |
| Approved Suppliers |               |                                   |         |                     |
| 1                  | B041A         | BHEL (BHOPAL)                     | INDIA   |                     |
| 2                  | C200          | CTR MANUFACTURING INDUSTRIES LTD  | INDIA   |                     |
| 3                  | E165          | EASUN-MR TAP CHANGERS P LTD       | INDIA   |                     |
| 4                  | O048          | ON LOAD GEARS                     | INDIA   |                     |



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| Sr No              | Supplier Code | Supplier Name                            | Country       | Holiday Description |
|--------------------|---------------|------------------------------------------|---------------|---------------------|
| Item Code : 14PA   |               | Description : PROTECTION RELAYS          |               |                     |
| Approved Suppliers |               |                                          |               |                     |
| 1                  | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD | INDIA         |                     |
| 2                  | S003B         | SIEMENS LTD - GOA                        | INDIA         |                     |
| 3                  | E143          | EASUN REYROLLE LTD                       | INDIA         |                     |
| 4                  | A070          | ABB INDIA LTD (BARODA)                   | 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 |
|--------------------|---------------|------------------------------------------------|---------|---------------------|
| Item Code : 14PB   |               | Description : PUSH BUTTON AND INDICATING LAMPS |         |                     |
| Approved Suppliers |               |                                                |         |                     |
| 1                  | B002          | BCH ELECTRIC LTD                               | INDIA   |                     |
| 2                  | E173          | ESSEN DEINKI                                   | INDIA   |                     |
| 3                  | S003          | SIEMENS LIMITED                                | INDIA   |                     |
| 4                  | L001C         | LARSEN & TOUBRO LTD-POWAI                      | INDIA   |                     |
| 5                  | S365          | SHRI TULSI SWITCHGEARS PVT LTD                 | INDIA   |                     |
| 6                  | H142          | HOTLINE SWITCHGEAR & CONTROLS                  | INDIA   |                     |
| 7                  | 4002          | P.P. INDUSTRIES                                | INDIA   |                     |
| 8                  | S450A         | SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD       | INDIA   |                     |
| 9                  | P291          | PRECIFINE PRODUCTS PVT. LTD.                   | INDIA   |                     |
| 10                 | T166          | TEKNIC ELECTRIC (I) PVT. LTD.                  | INDIA   |                     |



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



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



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| Sr No              | Supplier Code | Supplier Name                               | Country | Holiday Description |
|--------------------|---------------|---------------------------------------------|---------|---------------------|
| Item Code : 14WA   |               | Description : WINDING TEMPERATURE INDICATOR |         |                     |
| Approved Suppliers |               |                                             |         |                     |
| 1                  | P270          | PERFECT CONTROLS                            | INDIA   |                     |
| 2                  | P269          | PRECIMEASURE CONTROLS PVT.LTD.              | INDIA   |                     |



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# **MANDATORY SPARE LIST (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**

| E       | 07.04.2022 | REVISED AND REISSUED WITH TENDER | MKM         | RG         | HK          |
|---------|------------|----------------------------------|-------------|------------|-------------|
| D       | 01.04.2022 | REVISED AND REISSUED WITH TENDER | MKM         | RG         | HK          |
| C       | 27.09.2021 | REVISED AND REISSUED WITH TENDER | AKG         | HK         | HK          |
| B       | 05.07.2021 | REVISED AND REISSUED WITH TENDER | AKG         | HK         | HK          |
| Rev. No | Date       | Purpose                          | Prepared by | Checked by | Approved by |

Mandatory spares for applicable items shall be as per Clause 6.1 of Engineering Design Basis (Electrical), B269-999-16-50-EDB-1001 attached with the tender document.

In addition to the above following mandatory spare shall also be supplied:

[illegible]

**NOTES:**

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. The terminology used under 'Item Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
3. Wherever % age is identified, Contractor shall supply next rounded figure.
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 sub-packages as per mandatory spares philosophy specified elsewhere in the bid document.
7. \* 1 no. of each item for each EHV GIS i.e. separate set for 220kV indoor GIS, 220kV outdoor GIS, 66kV & 33kV indoor GIS.
8. \*\* 1 no. of each item for each location i.e. separate set for MRSS-100 (i.e. common set for 220kV & 66kV Indoor GIS) & New gantry substation( i.e. common set for 220kV Outdoor GIS and 33kV indoor GIS).

## Existing 220kV GIS System Details

**PROJECT : EPCM SERVICES FOR CAPACITY  
EXPANSION OF PANIPAT  
REFINERY (P25 PROJECT)**

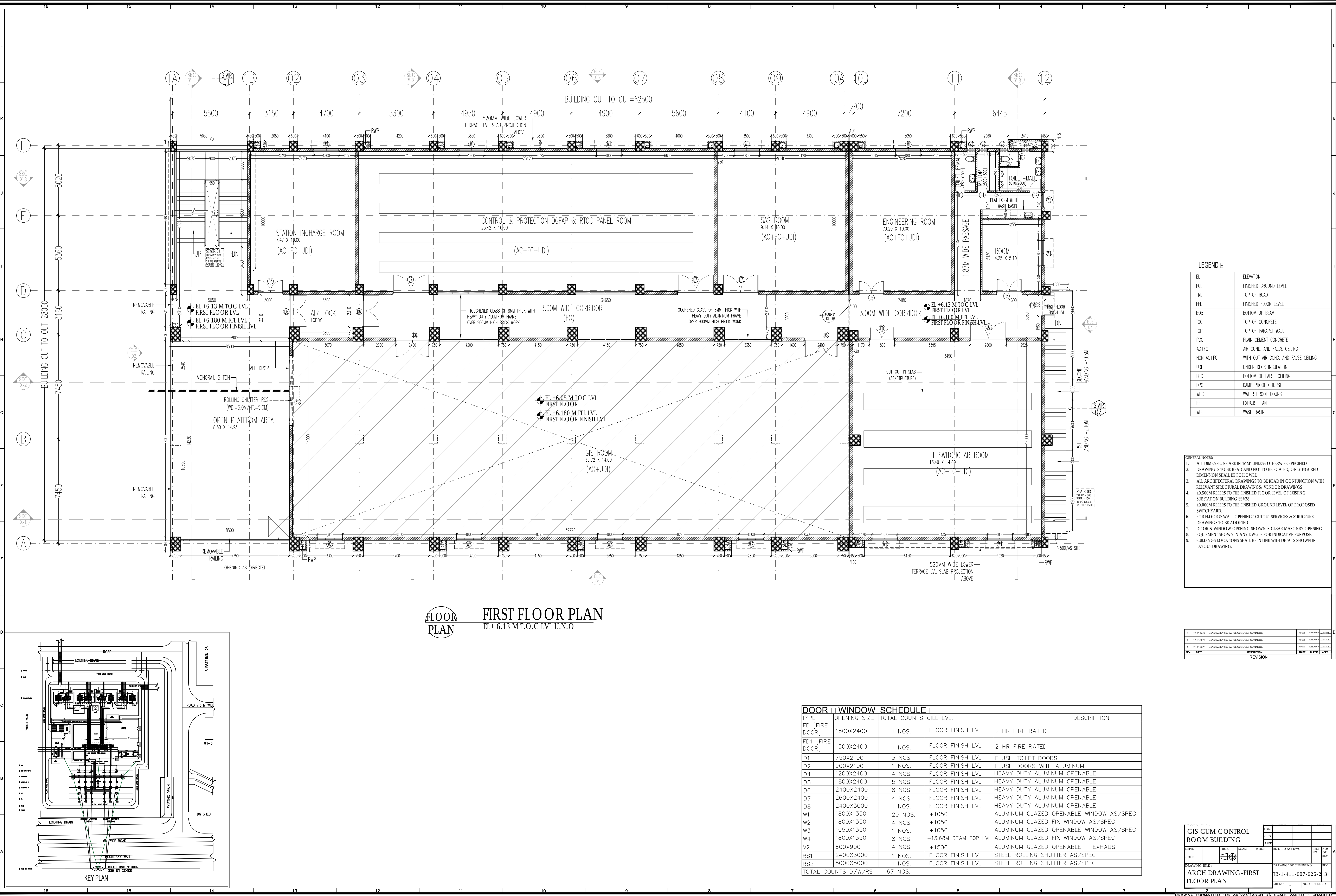
**CLIENT : M/s IOCL, PANIPAT REFINERY**

**EPCM : M/s ENGINEERS INDIA LTD.**

**JOB NO. : B269**



| S. No. | Item                                                        | Details Required                                                                                                                                                                                                                    | Site Inputs for Existing (BHEL) 220 KV GIS System                                                                                                                                                                                                                                                            |
|--------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <b>BUS BAR Protection Existing 220 KV GIS System (BHEL)</b> | Make and model of the existing Bus bar protection panel.                                                                                                                                                                            | Make: GE<br>Model: P74194NA6M0700K<br>Protection Type: Low Impedance differential protection<br>Redundant: Yes, both at CUA and PUA level.<br>Additional features: Main and Check features as per standard double bus configuration scheme.<br>Location: Dedicated Busbar protection panel in CRP type 2BB1. |
| 2      | <b>220 KV GIS Substation ( BHEL)</b>                        | <ul style="list-style-type: none"> <li>- Existing Switchyard equipment layout</li> <li>- Existing GIS building layout</li> <li>- Existing Lighting protection (DSLIP) layout</li> <li>- Existing Control building layout</li> </ul> | Documents Attached                                                                                                                                                                                                                                                                                           |
| 3      | <b>Online PD Monitoring System</b>                          | Online PD monitoring system make and Model.                                                                                                                                                                                         | MAKE: OHV<br>MODEL:- Model<br>TYPE:- Ultra High Frequency (UHF)<br>Suitable for :- N-type Connector<br>Case:- Portable                                                                                                                                                                                       |
| 4      | <b>CRP Panel</b>                                            | The details for the CRP Manufacturer name, and whether numerical relays with 61850 protocol are provided                                                                                                                            | CRP Make: GE T&D<br>The complete communication is on IEC-61850 only with any interfacing intermediate hardware.                                                                                                                                                                                              |
| 5      | <b>Substation Automation System</b>                         | Make and Model of SAS system                                                                                                                                                                                                        | SAS Make: GE T&D<br>Details attached.                                                                                                                                                                                                                                                                        |
| 6      | <b>Fire Alarm System</b>                                    | Details of the make and model of Fire alarm system at substation # 63 at PR.                                                                                                                                                        | The FA system to which the system is to be integrated with FA system of existing 220kV GIS Substation (BHEL Scope).<br>The DGFAP shall be located in PX control room.<br>Make: Bosch.                                                                                                                        |
| 7      | <b>Line Differential Relays</b>                             | The make and model of the Line differential relays at existing 220 KV GIS Substation .                                                                                                                                              | The make of Line differential protection is GE T&D only.<br>The details provided in CRP documents attached as Annex-1                                                                                                                                                                                        |
| 8      | <b>PLCC System ( BHEL -220 KV GIS System)</b>               | The details of the existing PLCC system – make and model.                                                                                                                                                                           | The PLCC details are attached.<br>PLCC & its associated hardware Make: ABB                                                                                                                                                                                                                                   |



| EL        | ELEVATION                            |
|-----------|--------------------------------------|
| FGL       | FINISHED GROUND LEVEL                |
| TRL       | TOP OF ROAD                          |
| FFL       | FINISHED FLOOR LEVEL                 |
| BOB       | BOTTOM OF BEAM                       |
| TOC       | TOP OF CONCRETE                      |
| TOP       | TOP OF PARAPET WALL                  |
| PCC       | PLAIN CEMENT CONCRETE                |
| AC+FC     | AIR COND. AND FALSE CEILING          |
| NON AC+FC | WITH OUT AIR COND. AND FALSE CEILING |
| UDI       | UNDER DECK INSULATION                |
| BFC       | BOTTOM OF FALSE CEILING              |
| DPC       | DAMP PROOF COURSE                    |
| WPC       | WATER PROOF COURSE                   |
| EF        | EXHAUST FAN                          |
| WB        | WASH BASIN                           |

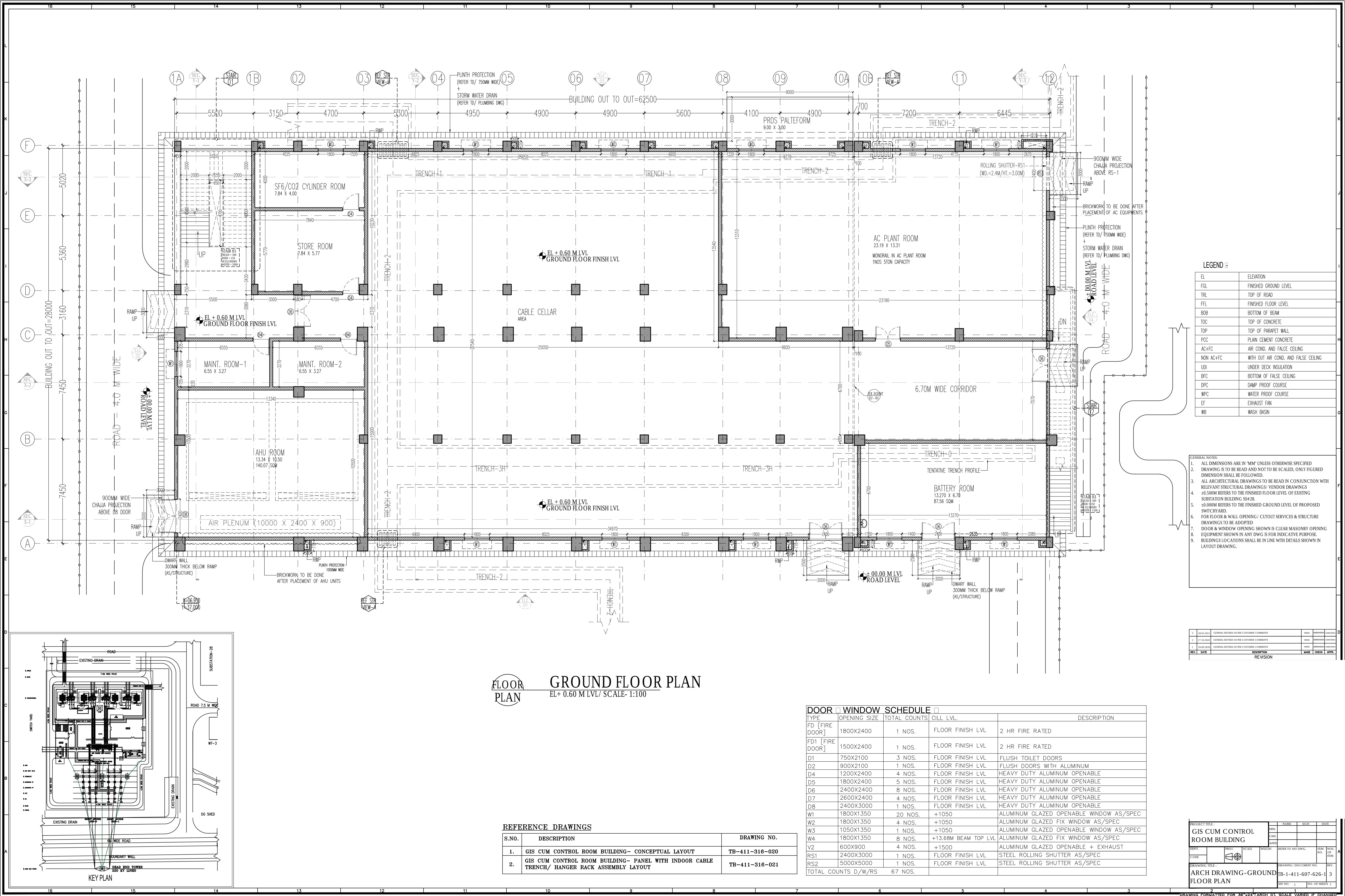
- GENERAL NOTES:
1. ALL DIMENSIONS ARE IN 'MM' UNLESS OTHERWISE SPECIFIED
  2. DRAWING IS TO BE READ AND NOT TO BE SCALED, ONLY FIGURED DIMENSION SHALL BE FOLLOWED.
  3. ALL ARCHITECTURAL DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT STRUCTURAL DRAWINGS/ VENDOR DRAWINGS
  4. +0.500M REFERS TO THE FINISHED FLOOR LEVEL OF EXISTING SUBSTATION BUILDING SS#28.
  5. +0.000M REFERS TO THE FINISHED GROUND LEVEL OF PROPOSED SWITCHYARD.
  6. FOR FLOOR & WALL OPENING/ CUTOUT SERVICES & STRUCTURE DRAWINGS TO BE ADOPTED
  7. DOOR & WINDOW OPENING SHOWN IN CLEAR MASONRY OPENING
  8. EQUIPMENT SHOWN IN ANY DWG IS FOR INDICATIVE PURPOSE.
  9. BUILDINGS LOCATIONS SHALL BE IN LINE WITH DETAILS SHOWN IN LAYOUT DRAWING.

| REV | DATE       | DESCRIPTION                               | MADE | CHECK | APPR. |
|-----|------------|-------------------------------------------|------|-------|-------|
| 1   | 20.08.2024 | GENERAL REVIEWED AS PER CUSTOMER COMMENTS |      |       |       |
| 2   | 27.08.2024 | GENERAL REVIEWED AS PER CUSTOMER COMMENTS |      |       |       |
| 3   | 26.09.2024 | GENERAL REVIEWED AS PER CUSTOMER COMMENTS |      |       |       |

| TYPE                | OPENING SIZE | TOTAL COUNTS | CILL LVL.            | DESCRIPTION                             |
|---------------------|--------------|--------------|----------------------|-----------------------------------------|
| FD [FIRE DOOR]      | 1800X2400    | 1 NOS.       | FLOOR FINISH LVL     | 2 HR FIRE RATED                         |
| FD1 [FIRE DOOR]     | 1500X2400    | 1 NOS.       | FLOOR FINISH LVL     | 2 HR FIRE RATED                         |
| D1                  | 750X2100     | 3 NOS.       | FLOOR FINISH LVL     | FLUSH TOILET DOORS                      |
| D2                  | 900X2100     | 1 NOS.       | FLOOR FINISH LVL     | FLUSH DOORS WITH ALUMINUM               |
| D4                  | 1200X2400    | 4 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| D5                  | 1800X2400    | 5 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| D6                  | 2400X2400    | 8 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| D7                  | 2600X2400    | 4 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| D8                  | 2400X3000    | 1 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| W1                  | 1800X1350    | 20 NOS.      | +1050                | ALUMINUM GLAZED OPENABLE WINDOW AS/SPEC |
| W2                  | 1800X1350    | 4 NOS.       | +1050                | ALUMINUM GLAZED FIX WINDOW AS/SPEC      |
| W3                  | 1050X1350    | 1 NOS.       | +1050                | ALUMINUM GLAZED OPENABLE WINDOW AS/SPEC |
| W4                  | 1800X1350    | 8 NOS.       | +13.68M BEAM TOP LVL | ALUMINUM GLAZED FIX WINDOW AS/SPEC      |
| V2                  | 600X900      | 4 NOS.       | +1500                | ALUMINUM GLAZED OPENABLE + EXHAUST      |
| RS1                 | 2400X3000    | 1 NOS.       | FLOOR FINISH LVL     | STEEL ROLLING SHUTTER AS/SPEC           |
| RS2                 | 5000X5000    | 1 NOS.       | FLOOR FINISH LVL     | STEEL ROLLING SHUTTER AS/SPEC           |
| TOTAL COUNTS D/W/RS |              | 67 NOS.      |                      |                                         |

| REV | DATE       | DESCRIPTION                               | MADE | CHECK | APPR. |
|-----|------------|-------------------------------------------|------|-------|-------|
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| 3   | 26.09.2024 | GENERAL REVIEWED AS PER CUSTOMER COMMENTS |      |       |       |





FLOOR PLAN  
GROUND FLOOR PLAN  
EL+0.60 M LVL/ SCALE: 1:100

REFERENCE DRAWINGS

| S.NO. | DESCRIPTION                                                                                | DRAWING NO.    |
|-------|--------------------------------------------------------------------------------------------|----------------|
| 1.    | GIS CUM CONTROL ROOM BUILDING- CONCEPTUAL LAYOUT                                           | TB-411-316-020 |
| 2.    | GIS CUM CONTROL ROOM BUILDING- PANEL WITH INDOOR CABLE TRENCH/ HANGER RACK ASSEMBLY LAYOUT | TB-411-316-021 |

| DOOR □ WINDOW SCHEDULE □ |              |              |                      |                                         |
|--------------------------|--------------|--------------|----------------------|-----------------------------------------|
| TYPE                     | OPENING SIZE | TOTAL COUNTS | CILL LVL.            | DESCRIPTION                             |
| FD [FIRE DOOR]           | 1800X2400    | 1 NOS.       | FLOOR FINISH LVL     | 2 HR FIRE RATED                         |
| FD1 [FIRE DOOR]          | 1500X2400    | 1 NOS.       | FLOOR FINISH LVL     | 2 HR FIRE RATED                         |
| D1                       | 750X2100     | 3 NOS.       | FLOOR FINISH LVL     | FLUSH TOILET DOORS                      |
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| D6                       | 2400X2400    | 8 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| D7                       | 2600X2400    | 4 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| D8                       | 2400X3000    | 1 NOS.       | FLOOR FINISH LVL     | HEAVY DUTY ALUMINUM OPENABLE            |
| W1                       | 1800X1350    | 20 NOS.      | +1050                | ALUMINUM GLAZED OPENABLE WINDOW AS/SPEC |
| W2                       | 1800X1350    | 4 NOS.       | +1050                | ALUMINUM GLAZED FIX WINDOW AS/SPEC      |
| W3                       | 1050X1350    | 1 NOS.       | +1050                | ALUMINUM GLAZED OPENABLE WINDOW AS/SPEC |
| W4                       | 1800X1350    | 8 NOS.       | +13.68M BEAM TOP LVL | ALUMINUM GLAZED FIX WINDOW AS/SPEC      |
| V2                       | 600X900      | 4 NOS.       | +1500                | ALUMINUM GLAZED OPENABLE + EXHAUST      |
| RS1                      | 2400X3000    | 1 NOS.       | FLOOR FINISH LVL     | STEEL ROLLING SHUTTER AS/SPEC           |
| RS2                      | 5000X5000    | 1 NOS.       | FLOOR FINISH LVL     | STEEL ROLLING SHUTTER AS/SPEC           |
| TOTAL COUNTS D/W/RS      |              | 67 NOS.      |                      |                                         |

LEGEND :

| EL        | ELEVATION                            |
|-----------|--------------------------------------|
| FGL       | FINISHED GROUND LEVEL                |
| TRL       | TOP OF ROAD                          |
| FFL       | FINISHED FLOOR LEVEL                 |
| BOB       | BOTTOM OF BEAM                       |
| TOC       | TOP OF CONCRETE                      |
| TOP       | TOP OF PARAPET WALL                  |
| PCC       | PLAIN CEMENT CONCRETE                |
| AC+FC     | AIR COND. AND FALSE CEILING          |
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| UDI       | UNDER DECK INSULATION                |
| BFC       | BOTTOM OF FALSE CEILING              |
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| EF        | EXHAUST FAN                          |
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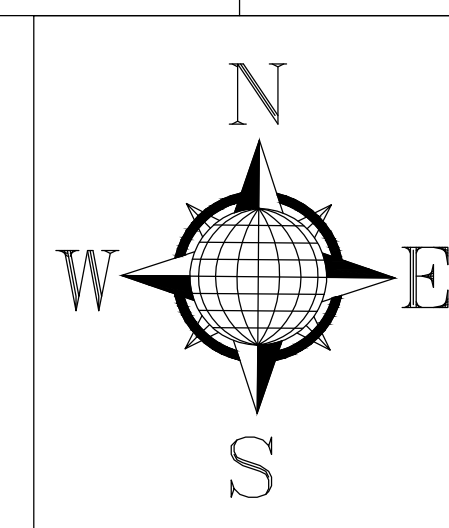
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|------|------------|-------------------------------------------|------|-------|-------|
| 1    | 20.08.2024 | GENERAL REVIEWED AS PER CUSTOMER COMMENTS |      |       |       |
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| 3    | 26.09.2024 | GENERAL REVIEWED AS PER CUSTOMER COMMENTS |      |       |       |

| PROJECT TITLE                  | NAME                 | SGIN          | DATE   |
|--------------------------------|----------------------|---------------|--------|
| GIS CUM CONTROL ROOM BUILDING  |                      |               |        |
| DEPT                           | PROJ                 | SCALE         | WEIGHT |
| CODE                           |                      |               |        |
| DRAWING TITLE                  | DRAWING DOCUMENT NO. | REV.          |        |
| ARCH DRAWING-GROUND FLOOR PLAN | TB-1-411-607-626-1   | 3             |        |
| SHT NO.                        | 1                    | NO. OF SHEETS | 1      |





NOTES:—

1. ALL DIMENSIONS ARE IN mm.
2. THE LOCATION OF TRENCHES/ HANGER & RACK ASSEMBLY MARKED IN THIS DRAWING MAY BE MODIFIED TO SUIT SITE CONDITIONS.
3. INSERTS MUST BE EMBEDDED FOR FIXING HANGER & RACK ASSEMBLY.
4. POWER CABLES SHALL BE LAID IN TOP TIERS AND CONTROL CABLES IN BOTTOM TIERS, AS PER TECHNICAL SPECIFICATION.
5. EARTH CONDUCTOR 50x6 GI FLAT SHALL BE RUN ALONG THE TOP TIER AND TO BE WELDED ON THE CABLE SUPPORT BEFORE INSTALLATION OF CABLES.
6. ALL OTHER DETAILS PERTAINING TO CIVIL WORKS SHALL REFLECT IN RESPECTIVE CIVIL DRAWINGS.
7. ENTRY/ EXIT OF CABLES SHALL BE THROUGH THE PIPE SLEEVES FOR TRENCH CONNECTING WITH BUILDING. FIRE SEALANTS SHALL BE PROVIDED AT THIS LOCATIONS.
8. CABLE TRAY IS SIZED CONSIDERING SINGLE LAYER OF CABLES FOR LT POWER CABLES, WHEREAS FOR CONTROL OR INSTRUMENTATION CABLES, MAXIMUM DOUBLE LAYER PER TRAY IS CONSIDERED.
9. SEPARATE CABLE TRAYS SHALL BE USED FOR LT POWER CABLE, LT CONTROL CABLE & INSTRUMENTATION CABLES/COMMUNICATION CABLE.
10. SUPPORT SPAN IS TO BE PROVIDED AT A DISTANCE OF 1500MM. INSERT PLATE SHALL SUITABLE FOR 3 TIER RACK ASSEMBLY BE PROVIDED IN TR-3H ALSO FOR FUTURE USE OF RACK ASSEMBLY.
11. CABLE TRAYS, RACKS AND TRENCHES IS SIZED TO ALLOW FOR 30% FUTURE CABLES
12. CABLE TRENCH SHOWN FOR FUTURE PANEL SHALL BE COVERED WITH CHEQUERED PLATE.
13. TRENCH SECTION-3H IN AHU ROOM SHALL BE IN BOX CULVERT FORM TO SUITABLE FOR SUSTAINING THE DYNAMIC LOADING OF AHU.



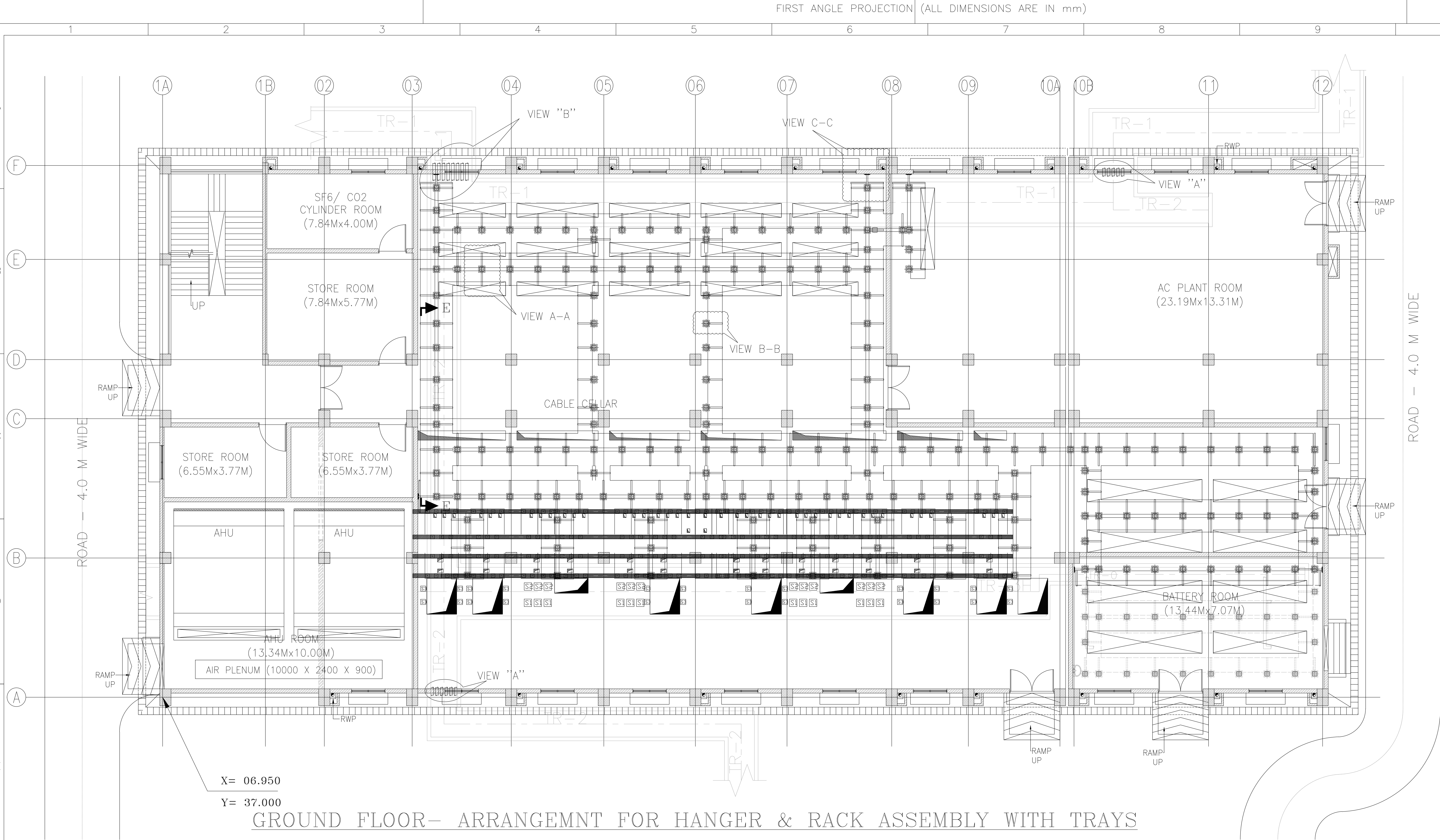
| REFERENCE DRAWING (S)/ DOCUMENT(S) -                                                                                         |                       |                                                  |
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| SL. NO.                                                                                                                      | DRAWING/ DOCUMENT NO. | DRAWING TITLE                                    |
| 1.                                                                                                                           | TB-411-316-020        | GIS CUM CONTROL ROOM BUILDING- CONCEPTUAL LAYOUT |
| PROJECT: LSTK JOB FOR ISBL WORK OF 220kV GRID POWER IMPORT AT PANIPAT REFINERY<br>LOA NO. RPRC182491/26286965 DTD.24.01.2020 |                       |                                                  |

|       |                                                                                          |    |                      |      |
|-------|------------------------------------------------------------------------------------------|----|----------------------|------|
| TITLE | GIS CUM CONTROL ROOM BUILDING-PANEL WITH INDOOR CABLE TRENCH/HANGER RACK ASSEMBLY LAYOUT |    | PROJECT DOCUMENT NO. | REV. |
|       |                                                                                          |    | TB-411-316-021       | 06   |
|       | SHT. No                                                                                  | 01 | NO. OF SHT.          | 03   |



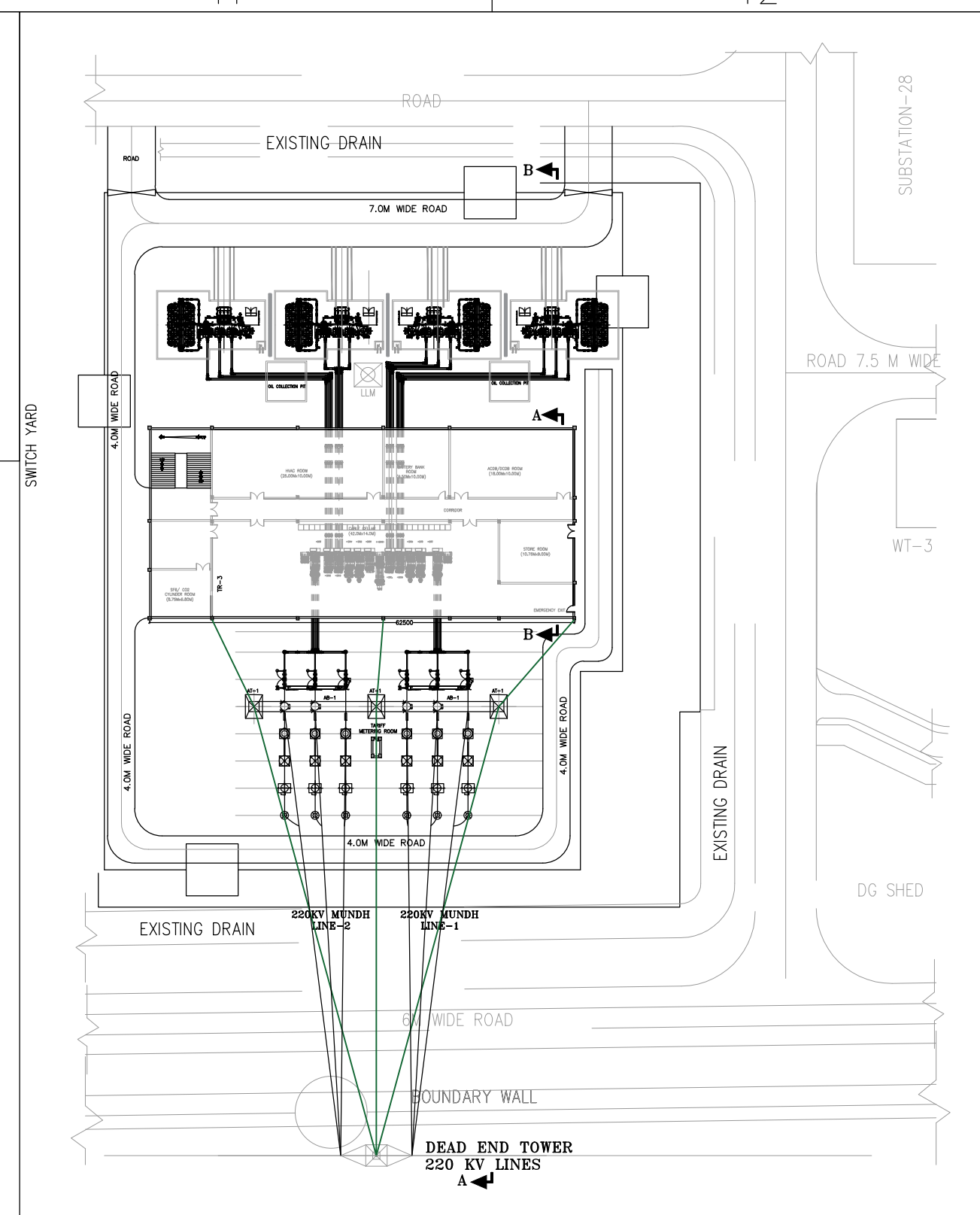
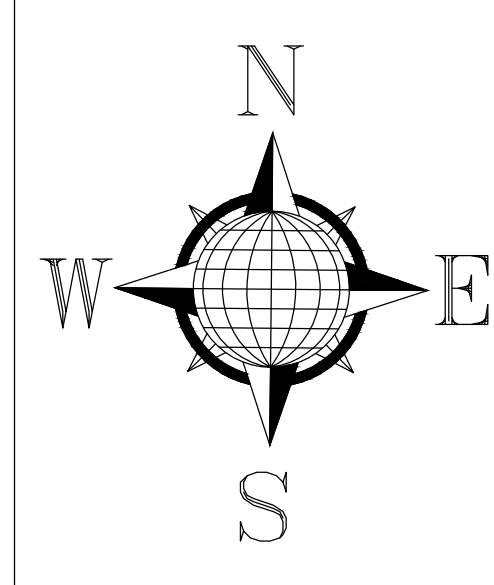
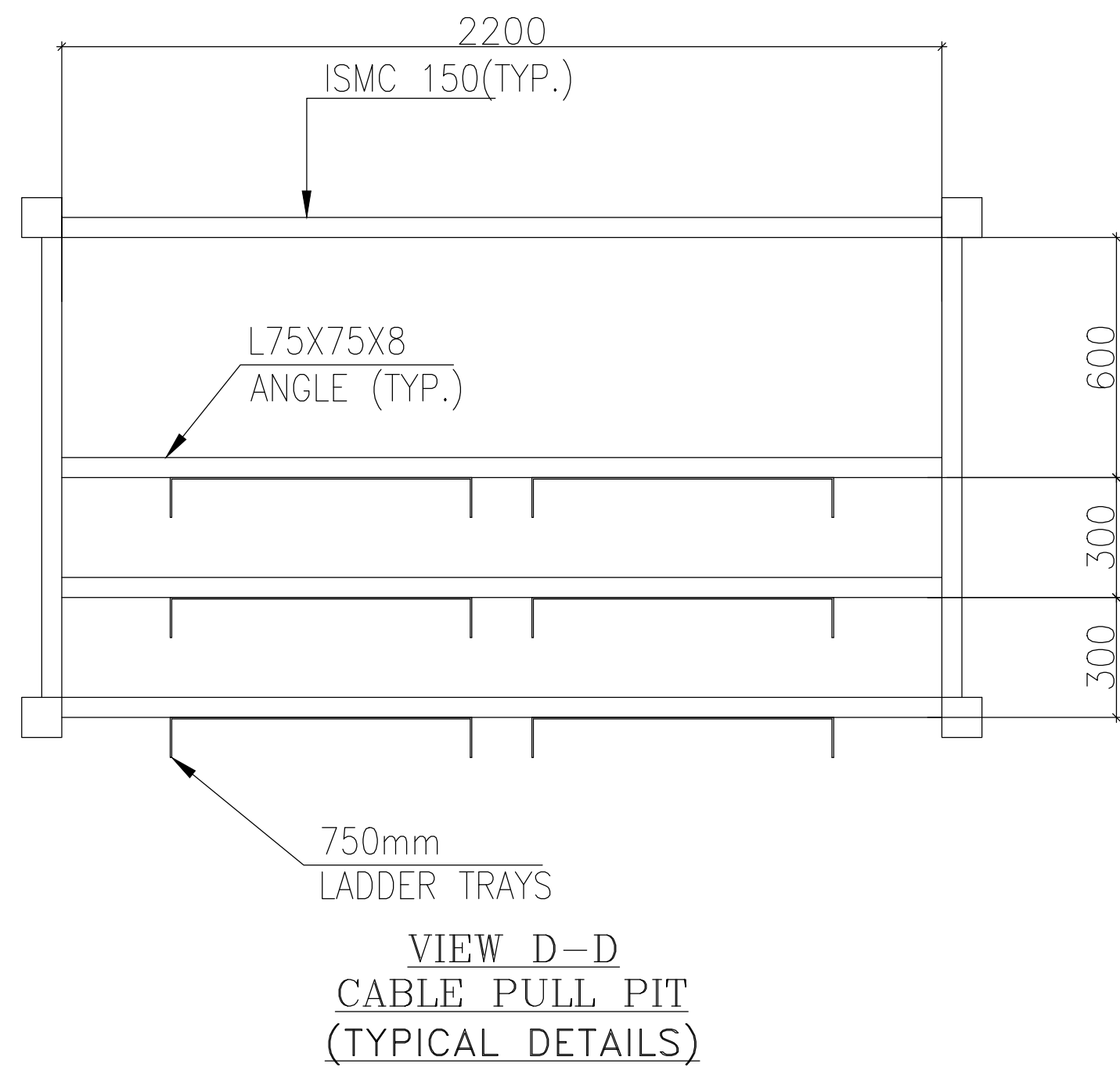
THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY

| INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. | COMPUTER FILE NAME |
|--------------|----------------|---------------|--------------------|
|              |                |               |                    |



X= 06.950  
Y= 37.000

GROUND FLOOR- ARRANGEMNT FOR HANGER & RACK ASSEMBLY WITH TRAYS



KEY PLAN

LEGEND:-

- SECONDARY CABLE TRENCH FOR INTERFACING CABLE BET GIS AND LCC WIDTH : 200x150mm
- SECONDARY CABLE TRENCH FOR INTERFACING CABLE LCC AND CONTROL ROOM, WIDTH:300x200mm
- CUTOUT FOR POWER CABLES BELOW CABLE END SIZE: 1560 x 1621 MM

REFERENCE DRAWING (S)/ DOCUMENT(S) -

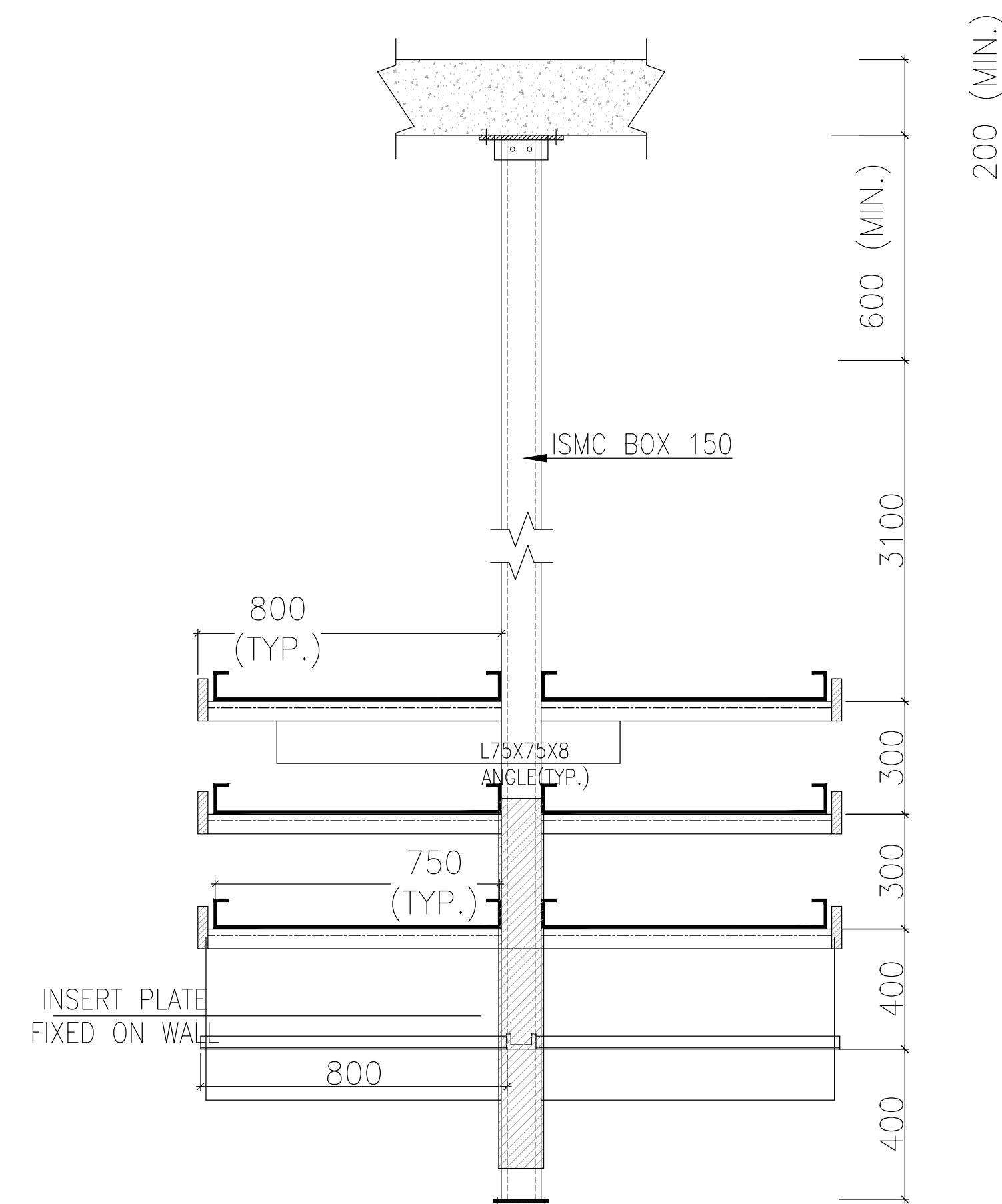
| SL. NO.                                                                        | DRAWING/ DOCUMENT NO. | DRAWING TITLE                                    |
|--------------------------------------------------------------------------------|-----------------------|--------------------------------------------------|
| 1.                                                                             | TB-411-316-020        | GIS CUM CONTROL ROOM BUILDING- CONCEPTUAL LAYOUT |
| PROJECT: LSTK JOB FOR ISBL WORK OF 220kV GRID POWER IMPORT AT PANIPAT REFINERY |                       |                                                  |
| I.OA NO. RPRC182491/26286965 DTD 24.01.2020                                    |                       |                                                  |

| REV. | DATE | ALTERED  | PK | REV. | DATE     | ALTERED  | PK  | REV. | DATE     | ALTERED  | PK  | REV. | DATE     | ALTERED  | PK  | REV. | DATE     | ALTERED  | PK  |
|------|------|----------|----|------|----------|----------|-----|------|----------|----------|-----|------|----------|----------|-----|------|----------|----------|-----|
|      |      | CHECKED  |    | 06   | 13.08.21 | CHECKED  | DKS | 05   | 03.03.21 | CHECKED  | DKS | 04   | 10.02.21 | CHECKED  | DKS | 03   | 08.01.21 | CHECKED  | DKS |
|      |      | APPROVED |    |      |          | APPROVED | VK  |      |          | APPROVED | VK  |      |          | APPROVED | VK  |      |          | APPROVED | VK  |
| ZONE |      |          |    | ZONE |          |          |     | ZONE |          |          |     | ZONE |          |          |     | ZONE |          |          |     |
|      |      |          |    |      |          |          |     |      |          |          |     |      |          |          |     |      |          |          |     |

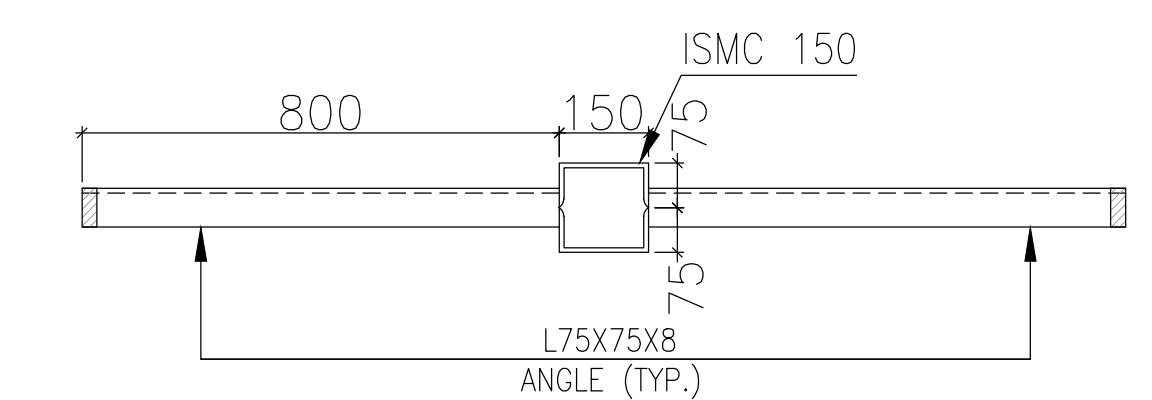
TITLE GIS CUM CONTROL ROOM BUILDING-  
PANEL WITH INDOOR CABLE TRENCH/  
HANGER RACK ASSEMBLY LAYOUT

|                      |                |             |    |
|----------------------|----------------|-------------|----|
| PROJECT DOCUMENT NO. | TB-411-316-021 | REV.        | 06 |
| SHT. No              | 02             | NO. OF SHT. | 03 |





VIEW C-C  
(TYPICAL DETAILS)



CABLE CELLAR  
CORRIDOR

REFERENCE DRAWING (S)/ DOCUMENT(S) -

TITLE GIS CUM CONTROL ROOM BUILDING-  
PANEL WITH INDOOR CABLE TRENCH/  
HANGER RACK ASSEMBLY LAYOUT

|                       |                 |      |
|-----------------------|-----------------|------|
| PROPERTY DOCUMENT NO. |                 | REV. |
| TB-411-316-021        |                 | 06   |
| DATE: 03              | NO. OF SETS: 03 |      |

| REV. | DATE | ALTERED  |          | REV. | DATE                                                                                          | ALTERED  |          | REV. | DATE                                                                                        | ALTERED  |          | REV. | DATE                                                          | ALTERED  |          | REV. | DATE                                                                                        | ALTERED  |          |      |                                                                                             |  |  |      |                                                                                             |
|------|------|----------|----------|------|-----------------------------------------------------------------------------------------------|----------|----------|------|---------------------------------------------------------------------------------------------|----------|----------|------|---------------------------------------------------------------|----------|----------|------|---------------------------------------------------------------------------------------------|----------|----------|------|---------------------------------------------------------------------------------------------|--|--|------|---------------------------------------------------------------------------------------------|
|      |      | CHECKED  | PK       |      |                                                                                               | CHECKED  | PK       |      |                                                                                             | CHECKED  | PK       |      |                                                               | CHECKED  | PK       |      |                                                                                             | CHECKED  | PK       |      |                                                                                             |  |  |      |                                                                                             |
|      |      | Detailed | Comments |      |                                                                                               | Detailed | Comments |      |                                                                                             | Detailed | Comments |      |                                                               | Detailed | Comments |      |                                                                                             | Detailed | Comments |      |                                                                                             |  |  |      |                                                                                             |
|      |      | CHECKED  | PK       |      |                                                                                               | CHECKED  | PK       |      |                                                                                             | CHECKED  | PK       |      |                                                               | CHECKED  | PK       |      |                                                                                             | CHECKED  | PK       |      |                                                                                             |  |  |      |                                                                                             |
|      |      | APPROVED | VK       |      |                                                                                               | APPROVED | VK       |      |                                                                                             | APPROVED | VK       |      |                                                               | APPROVED | VK       |      |                                                                                             | APPROVED | VK       |      |                                                                                             |  |  |      |                                                                                             |
| ZONE |      |          |          | ZONE | AS PER REVISED INSERT PLATES, AND CUTOUT DETAILS FINALIZED WITH M/S CGPISL AND OTHER VENDORS. |          |          | ZONE | AS PER CONSULTANT/TCE AND CUSTOMER/IOCL COMMENTS DTD. 17.02.2021 & 23.02.2021 RESPECTIVELY. |          |          | ZONE | STRUCTURE DETAILS CHANGED AS PER ACTUAL LOADING REQUIREMENTS. |          |          | ZONE | AS PER CONSULTANT/TCE AND CUSTOMER/IOCL COMMENTS DTD. 12.10.2020 & 15.10.2020 RESPECTIVELY. |          |          | ZONE | AS PER CONSULTANT/TCE AND CUSTOMER/IOCL COMMENTS DTD. 07.09.2020 & 10.09.2020 RESPECTIVELY. |  |  | ZONE | AS PER CONSULTANT/TCE AND CUSTOMER/IOCL COMMENTS DTD. 05.08.2020 & 05.08.2020 RESPECTIVELY. |



**Partial Discharge Sensor**

- 1) Type of Mounting : Intruded into GIS
- 2) Type of operation : Ultra High Frequency (UHF)
- 3) Connector : N type
- 4) Frequency : 200MHz – 2000MHz
- 5) No of Sensors on Typical Single-Phase Enclosed 245kV GIS Bay : 2 Nos per phase or 6 Nos per Bay.
- 6) No of Sensors on Typical Single-Phase Enclosed 245kV GIS Busduct : Depends on Length of Busduct, UHF Sensors shall be added in Busduct as shown in project specific SLD.

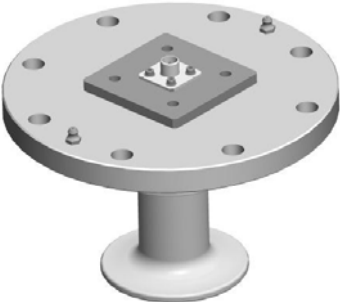
| UHF PD Sensor                                                                      | Mounted on GIS Enclosure                                                            |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |

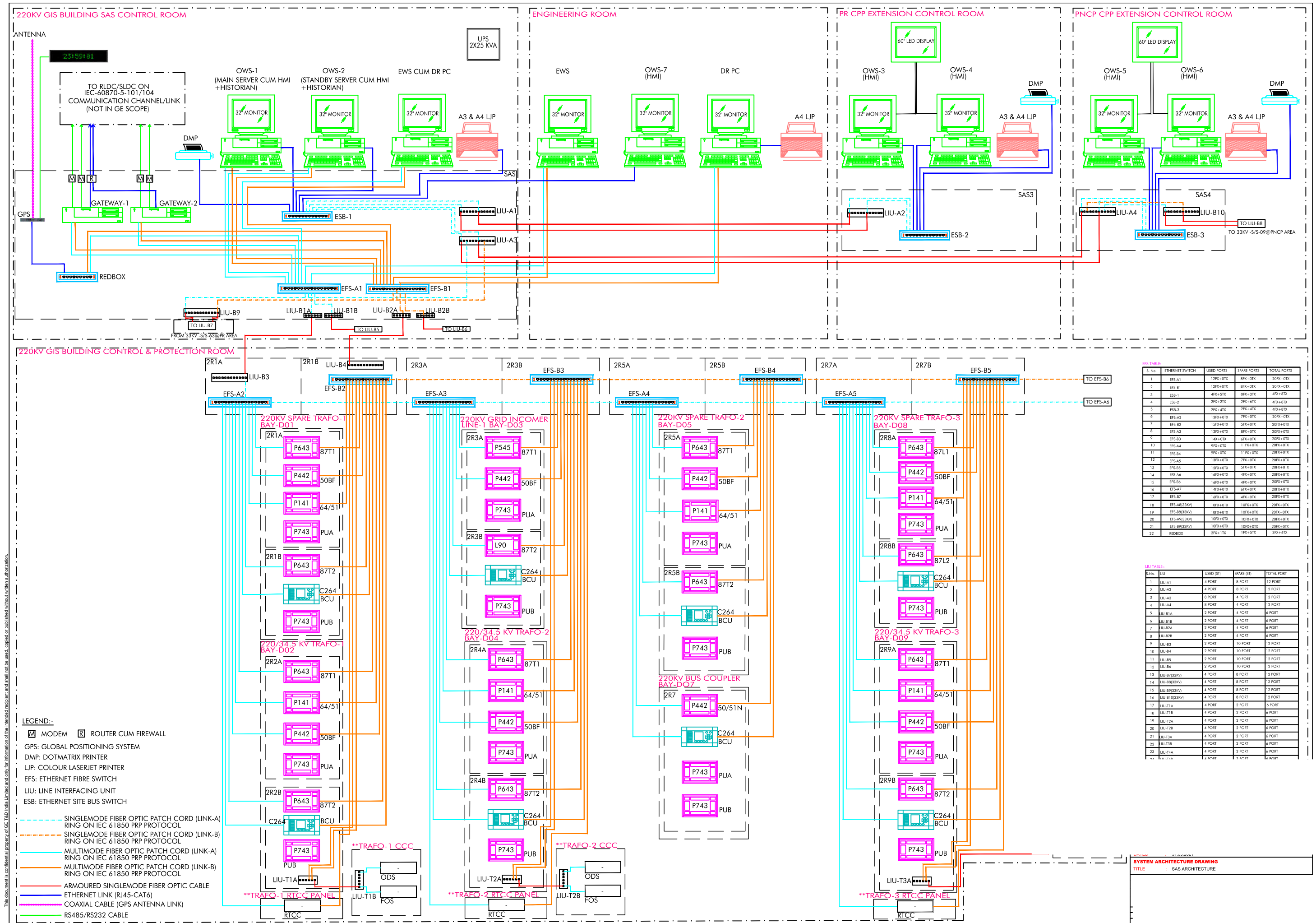
Fig:1

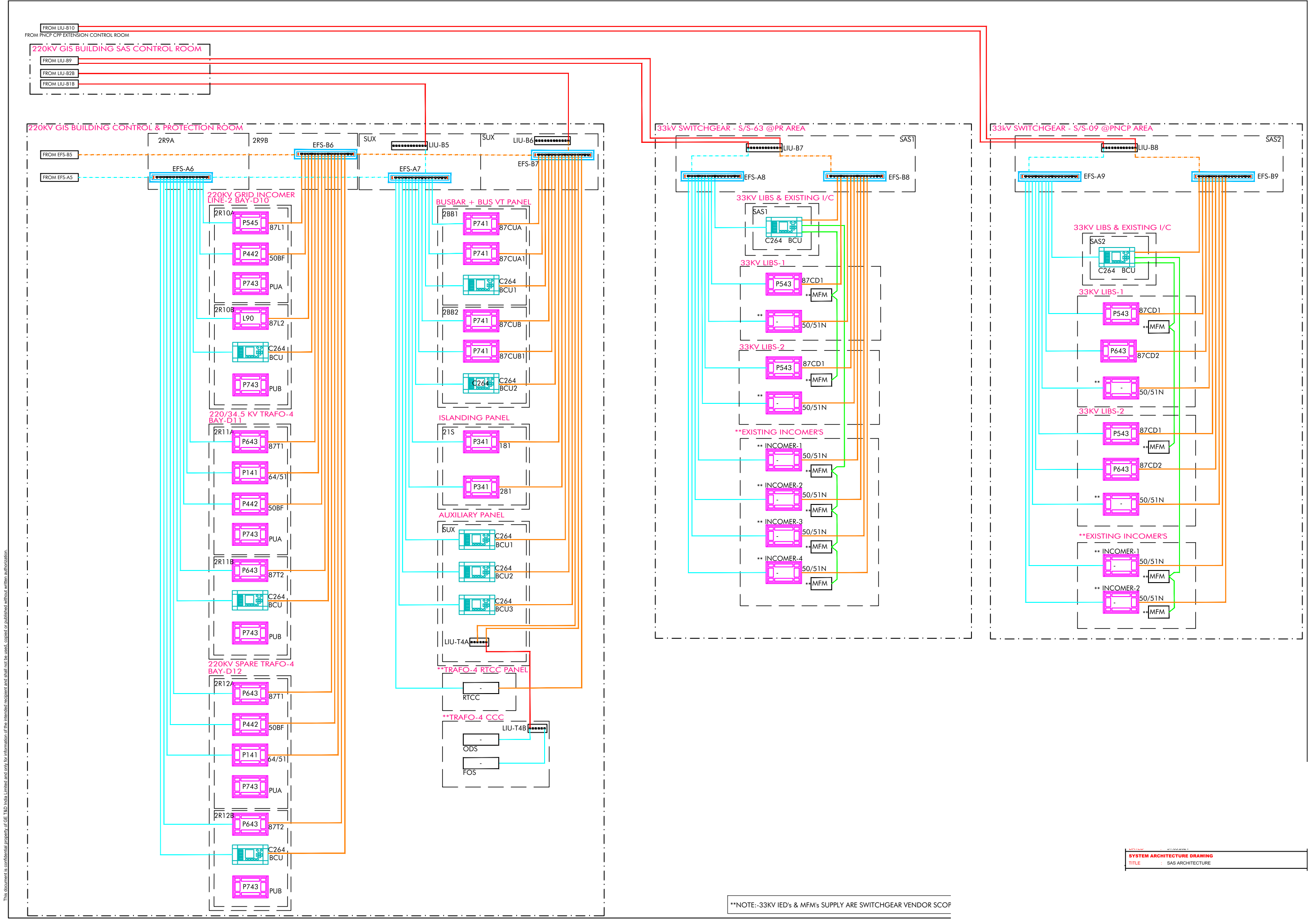


|                                            |                                                                                                                             |
|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| B.6                                        |                                                                                                                             |
| <b>Supply: Maintenance Equipment-</b>      | <b>Maintenance Equipment- Online Portable PD analyzer/ measurement kit suitable for GIS along with required accessories</b> |
| <b>GAURANTEED TECHNICAL PARAMETERS FOR</b> |                                                                                                                             |
| Purpose                                    | Analyse Partial Discharge activity inside GIS when GIS is in Service                                                        |
| Case                                       | Portable                                                                                                                    |
| Type                                       | Ultra High Frequency (UHF)                                                                                                  |
| No of Channels                             | Three (UHF)                                                                                                                 |
| Suitable for                               | N-type Connector                                                                                                            |
| Measurement range                          | 50 MHz to 2 GHz                                                                                                             |
| Detection sensitivity                      | -75 dB                                                                                                                      |
| Dynamic Range                              | 60 dB                                                                                                                       |
| Reported value                             | Signal peaks in mV                                                                                                          |
| Synch Voltage channel                      | 1                                                                                                                           |
| Synch Voltage freq.                        | 20 Hz to 200 Hz                                                                                                             |
| Resolution                                 | 12 bit                                                                                                                      |
| External power supply                      | 110V – 230V AC +/- 10%, 50Hz/60 Hz                                                                                          |
| Make                                       | OHV                                                                                                                         |
| Model                                      | PDD-3M_UHF                                                                                                                  |
| Catalog Enclosed                           | Yes                                                                                                                         |

|                     |                                          |
|---------------------|------------------------------------------|
| Method of Statement | As per approved document No . 20606D-371 |
|---------------------|------------------------------------------|

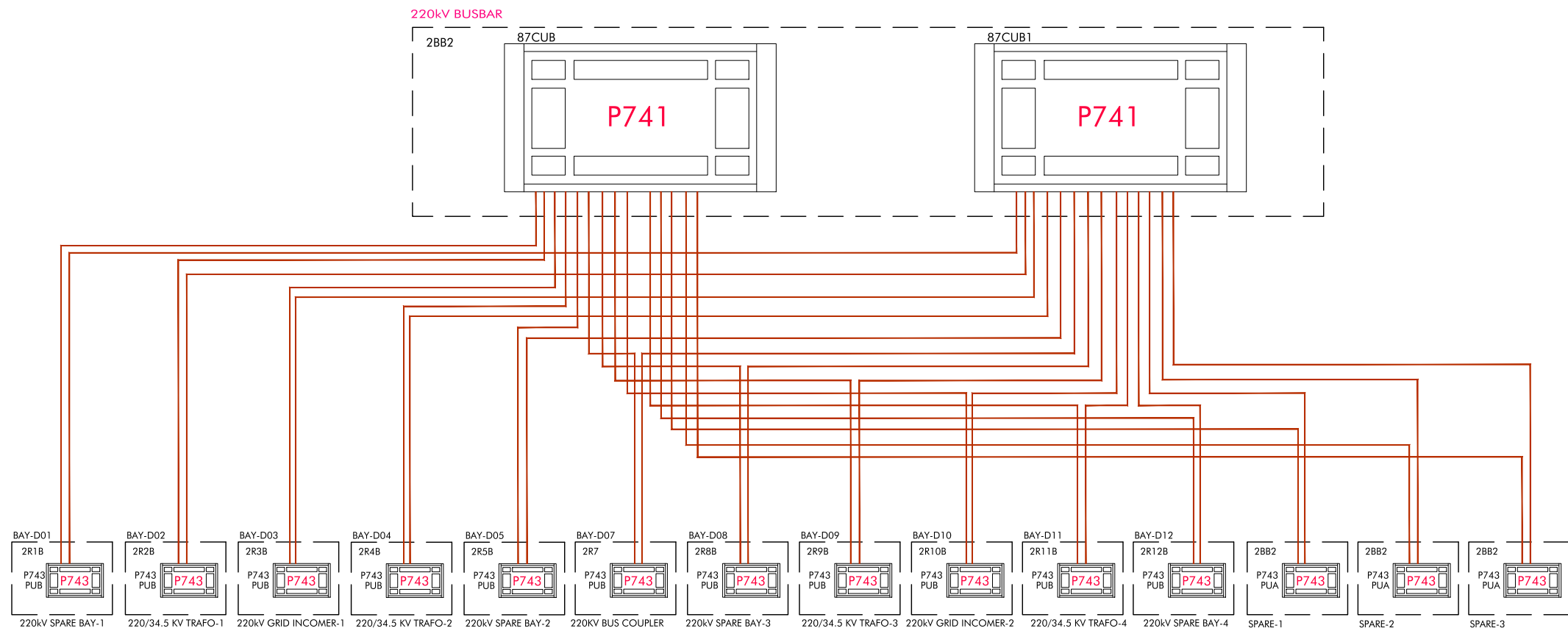
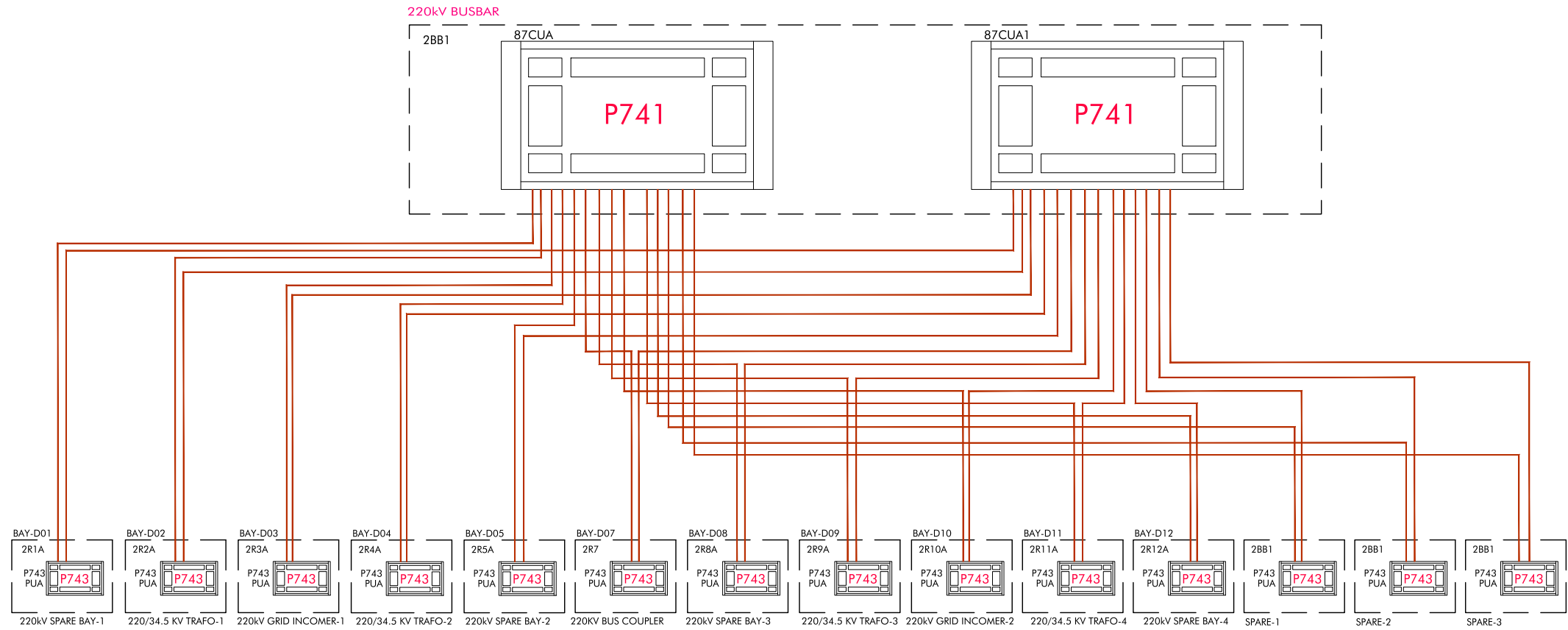
|                                            |            |
|--------------------------------------------|------------|
| <b>BILL OF MATERIALS</b>                   |            |
| 1. Portable UHF partial discharge Analyzer | 1 No       |
| 2. Software                                | 1 No       |
| 3. Laptop                                  | 1 No       |
| 4. Pulse Generator                         | 1 No       |
| 5. UHF Sensors (fixed in GIS)              | As per SLD |
| 6. Connecting Cables/Accessories           | 1 Set      |





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LEGEND:-

MULTIMODE FIBER OPTIC PATCH CORD

DATED : 31.03.2021

SYSTEM ARCHITECTURE DRAWING

TITLE : BUSBAR ARCHITECTURE

# I. SAS EQUIPMENTS

## 1. BAY CONTROL UNIT

| S.No. | Equipment                       | Specification                                                                                                                                                                                      |
|-------|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Make                            | GE T&D India Limited                                                                                                                                                                               |
| 2     | Model                           | C264                                                                                                                                                                                               |
| 3     | Configuration of I/O Cards      | As per Scheme                                                                                                                                                                                      |
| 4     | Mimic on BCU                    | LCD display, LED's - 4 System & 13 Programmable, Keypad for local control.                                                                                                                         |
| 5     | Power Supply Board              |                                                                                                                                                                                                    |
|       | Aux. Supply / Power / Watchdog  | 220V DC / 60W / One watchdog relay (closed if healthy)                                                                                                                                             |
|       | Communication Port – 1          | Configurable RS232/485 (insulated),                                                                                                                                                                |
|       | Communication Port – 2          | Configurable RS232/422/485 (Insulated)                                                                                                                                                             |
|       | Communication Port: Ethernet    | 10/100 Base Ethernet/Fiber Port                                                                                                                                                                    |
|       | Inbuilt Function: Auto recloser | Yes                                                                                                                                                                                                |
| 6     | Digital Input Board             |                                                                                                                                                                                                    |
|       | No. of Channels                 | 16 optically insulated DI with 1 common for 2 inputs                                                                                                                                               |
|       | Scanning period                 | 1ms                                                                                                                                                                                                |
| 7     | Digital Output Board            |                                                                                                                                                                                                    |
|       | No. of Channels                 | 8 Single pole Relays with One Normally Open contact (NO),<br>2 Single pole Relays with one common for 2 Outputs (NO/NC)<br>Current carrying capacity: 5A continuous, 30A for 500ms & 100A for 30ms |
|       | Breaking capacity               | DC: 50W resistive, 30W inductive (L/R = 40 ms),<br>AC: 1250VA resistive, 1250VA inductive (cos $\Phi$ = 0,7)                                                                                       |
| 8     | Analogue Input Board            |                                                                                                                                                                                                    |
|       | No. of Channels                 | 8 Modular independent analogue inputs of opto-isolated AI on one board (currents)16 bits A/D converter (15 bits + sign)                                                                            |
|       | Scanning period                 | 100ms to 1000ms – Configurable                                                                                                                                                                     |
| 9     | Transducer less CT/VT module    |                                                                                                                                                                                                    |
|       | CT/VT                           | 4 CT of two ranges – 1/5 Amperes<br>5 VT Nominal voltage 57.73 to 500 Vrms                                                                                                                         |
|       | Accuracy of measurement         | Current: 0.2% full scale, Voltage: 0.2% full scale, Frequency: + 0.01 Hz                                                                                                                           |
| 10    | Communication Protocol          | IEC61850 - PRP                                                                                                                                                                                     |
| 11    | Time synchronization Protocol   | SNTP                                                                                                                                                                                               |

## 2. SYNCHRONISING CHECK FUNCTION

| S.No. | Equipment                                                                                                                                                                                                                                             | Specification                               |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| 1     | Manufacturer type & designation                                                                                                                                                                                                                       | Built-in function of Bay Control Unit C264  |
| 2     | Phase angle setting                                                                                                                                                                                                                                   | Variable between 0° – 90° in steps of 1deg. |
| 3     | Voltage difference setting                                                                                                                                                                                                                            | 0 to 100% in steps of 1%                    |
| 4     | Whether dead line charging relay included?                                                                                                                                                                                                            | Yes (In built)                              |
| 5     | Frequency                                                                                                                                                                                                                                             | 0 to 1Hz in steps of 0.01 Hz                |
| 6     | Operation indicator provided                                                                                                                                                                                                                          | Yes                                         |
| 7     | Suitable for single & three phase?                                                                                                                                                                                                                    | Yes                                         |
| 8     | Whether Deadline charging relay will be able to monitor the 3-phase voltage<br>- one set connected to line CVTs with a fixed setting of 0.2 X rated voltage<br>- One set connected to bus CVTs with a fixed setting of 0.80 X rated voltage provided? | Yes, provided (In built)                    |

### 3. OPERATOR WORKSTATION / ENGINEERING / DR WORKSTATION PC

| S.No. | Equipment             | Specification                                                                                            |
|-------|-----------------------|----------------------------------------------------------------------------------------------------------|
| 1     | Make                  | ADVANTECH                                                                                                |
| 2     | Power Supply          | Industrial SMPS 400W + 400W – Dual Redundant – Wide Range 96 ~ 264V AC - Auto                            |
| 3     | Processor             | Intel Xeon(R) @ 3.20GHz                                                                                  |
| 4     | RAM                   | 32GB DDR3                                                                                                |
| 5     | HDD                   | 1 TB SATA Drive                                                                                          |
| 6     | CD Drive              | DVD RW (Support at least Read (48x), Write (24x) & Rewrite (10x) operations with multi-session capacity. |
| 7     | Operating Temperature | 0° to 40°C                                                                                               |
| 8     | Relative Humidity     | 10 to 95% @ 40°C, non-condensing                                                                         |
| 9     | Vibration             | 5 – 500 Hz                                                                                               |
| 10    | Operating System      | Windows 10 LTSC                                                                                          |
| 11    | Input /Outputs        | VGA: 1, USB: 6,<br>Audio: 2 (LINE-Out and MIC-In)<br>USB Keyboard & Mouse: 1                             |
| 12    | Ethernet Port Details | Dual Gigabit Ethernet Interface: 10/100/1000Base                                                         |
| 13    | OWS Software          | DS Agile                                                                                                 |
| 14    | EWS Software          | S1 Agile, GE Enervista,                                                                                  |

### 4. GATEWAY PC

| S. No. | Equipment             | Specification                                                                                            |
|--------|-----------------------|----------------------------------------------------------------------------------------------------------|
| 1      | Make                  | ADVANTECH                                                                                                |
| 2      | Power Supply          | 230 V AC / 220V DC, 300W                                                                                 |
| 3      | Processor             | Intel CORE i7                                                                                            |
| 4      | RAM                   | 8 GB DDR3                                                                                                |
| 5      | HDD                   | 1 TB SATA Drive                                                                                          |
| 6      | CD Drive              | DVD RW (Support at least Read (48x), Write (24x) & Rewrite (10x) operations with multi-session capacity. |
| 7      | Operating Temperature | 0° to 40°C                                                                                               |
| 8      | Relative Humidity     | 10 to 95% @ 40°C, non-condensing                                                                         |
| 9      | Vibration             | 5 – 500 Hz                                                                                               |
| 11     | Operating System      | Windows 10 LTSC                                                                                          |
| 12     | Input /Outputs        | VGA: 1, USB: 6,<br>Audio: 2 (LINE-Out and MIC-In), Serial: 2 Nos RS-232                                  |
| 13     | Ethernet Port Details | Dual Gigabit Ethernet Interface: 10/100/1000Base-T<br>Connector: RJ-45 x 2                               |
| 14     | Gateway Software      | DS Agile                                                                                                 |

## 5. LAPTOP

| S. No. | Equipment                         | Specification                                                         |
|--------|-----------------------------------|-----------------------------------------------------------------------|
| 1      | Make                              | DELL/HP                                                               |
| 2      | Processor                         | Intel CORE i7                                                         |
| 3      | RAM                               | 4 GB or higher                                                        |
| 4      | HDD                               | 1 TB SATA Drive                                                       |
| 5      | Operating System                  | Windows 10                                                            |
| 6      | Input /Outputs                    | USB: 4<br>Serial Port : USB to serial port converter (External)       |
| 7      | Ethernet Port Details             | Gigabit Ethernet Interface: 10/100/1000Base-T<br>Connector: RJ-45 x 1 |
| 8      | Keyboard & Optical Mouse with Pad | Non backlit Inbuilt Laptop Keyboard, External Mouse                   |

## 6. MONITOR

| S.No. | Equipment          | Specification                   |
|-------|--------------------|---------------------------------|
| 1     | Make               | SAMSUNG/DELL                    |
| 2     | Type               | LED                             |
| 3     | Viewable Size      | 32"                             |
| 4     | Resolution         | 1920x 1080                      |
| 5     | Interface          | Analogue/Digital                |
| 6     | Input video signal | Analogue RGB, TMDS Digital Link |
| 7     | Input connectors   | 15 pin D-Sub/USB, DVI-D/HDMI    |
| 8     | Power Consumption  | 77W (max.),240V AC 50Hz         |
| 9     | Stand Type         | Adjustable                      |
| 10    | Viewing Angle      | 178 vertical / 178 horizontal   |
| 11    | Contrast Ratio     | 1000 to 1 (typical)             |

## 7. LED DISPLAY

| S.No. | Equipment          | Specification                   |
|-------|--------------------|---------------------------------|
| 1     | Make               | SAMSUNG                         |
| 2     | Type               | LED                             |
| 3     | Viewable Size      | 65"                             |
| 4     | Resolution         | 1920x 1080 or higher            |
| 5     | Interface          | Analogue/Digital                |
| 6     | Input video signal | Analogue RGB, TMDS Digital Link |
| 7     | Input connectors   | 15 pin D-Sub/USB,VGA/DVI-D/HDMI |
| 8     | Power Consumption  | 181W (max.),240V AC 50Hz        |
| 9     | Stand Type         | Wall mount                      |
| 10    | Viewing Angle      | 178 vertical / 178 horizontal   |
| 11    | Contrast Ratio     | 1000 to 1 (typical)             |



## 8. DOT MATRIX PRINTER

| S.No. | Equipment                              | Specification                                                    |
|-------|----------------------------------------|------------------------------------------------------------------|
| 1     | Make                                   | EPSON                                                            |
| 2     | Print Head                             | 24 pin                                                           |
| 3     | Print Modes                            | Draft and LQ                                                     |
| 4     | Print Width                            | 136 Column                                                       |
| 5     | Print Speed                            | 250 cps @ 10 cpi in draft mode<br>375 cps @ 15 cpi in draft mode |
| 6     | Print Method                           | Impact dot matrix                                                |
| 7     | Paper Feed                             | Tractor (Push and Pull) Rear in, Top out                         |
| 8     | Paper Type                             | Cut sheet & Fan-Fold continuous stationary                       |
| 9     | Data Buffer                            | 24KB (min.)                                                      |
| 10    | Print Attributes                       | Bold, Italics, underline, wide-font, super and sub-scripting     |
| 11    | Interface                              | 10/100 Base TX External Print Server                             |
| 12    | Power supply                           | AC 90 to 270V, Approx. 30W                                       |
| 13    | Inbuilt testing facility               | Provided                                                         |
| 14    | Offline mode selection for maintenance | Provided                                                         |
| 15    | Environmental                          | 5-35 Deg @ 10-80% RH                                             |

## 9. A4 MULTIFUNCTION PRINTER

| S.No. | Equipment                | Specification                     |
|-------|--------------------------|-----------------------------------|
| 1     | Make                     | Xerox/Canon/HP                    |
| 2     | Type                     | A4 Colour LaserJet                |
| 3     | Print Speed (Black)      | 17 ppm or above                   |
| 4     | Print Speed (Colour)     | 4 ppm or above                    |
| 5     | Processor Speed          | 360 MHz or above                  |
| 6     | Duty Cycle (monthly, A4) | Up to 50000 pages per month       |
| 7     | Resolution               | Up to 600 X 600 DPI or above      |
| 8     | Interface                | Hi-Speed USB 2.0 Port, Ethernet   |
| 9     | Memory                   | 64 MB or above                    |
| 10    | Standard Input Capacity  | Up to 350 (Sheets) or above       |
| 11    | Power supply             | 220V +/- 10V (50Hz AC supply)     |
| 12    | Power Consumption        | Active: 445W or higher, Ready:18W |

## 10. A3 cum A4 MULTIFUNCTION PRINTER

| S.No. | Equipment                | Specification                     |
|-------|--------------------------|-----------------------------------|
| 1     | Make                     | Xerox                             |
| 2     | Type                     | A3 & A4 Colour LaserJet           |
| 3     | Print Speed (Black)      | 17 ppm or above                   |
| 4     | Print Speed (Colour)     | 4 ppm or above                    |
| 5     | Processor Speed          | 360 MHz or above                  |
| 6     | Duty Cycle (monthly, A4) | Up to 50000 pages per month       |
| 7     | Resolution               | Up to 600 X 600 DPI or above      |
| 8     | Interface                | Hi-Speed USB 2.0 Port, Ethernet   |
| 9     | Memory                   | 64 MB or above                    |
| 10    | Standard Input Capacity  | Up to 350 (Sheets) or above       |
| 11    | Power supply             | 220V +/- 10V (50Hz AC supply)     |
| 12    | Power Consumption        | Active: 445W or higher, Ready:18W |

## 11. TIME SYNCHRONISATION UNIT

| S.No. | Equipment                          | Specification                                                                                                                                                                                                                                    |
|-------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Make                               | SERTEL/Masibus                                                                                                                                                                                                                                   |
| 2     | Operating Temp.                    | 0° to 50°C                                                                                                                                                                                                                                       |
| 3     | Humidity                           | 90% at 40 ° C (Non-condensing)                                                                                                                                                                                                                   |
|       | GPS Receiver                       |                                                                                                                                                                                                                                                  |
| 4     | Size                               | 19" Rack-Mount                                                                                                                                                                                                                                   |
| 5     | Power Supply                       | 230V AC / 220V DC                                                                                                                                                                                                                                |
| 6     | Display                            | Min. 2x20 Character Super twist LCD                                                                                                                                                                                                              |
| 7     | Functions                          | <ul style="list-style-type: none"> <li>Time: UTC or Local</li> <li>Position: Latitude, Longitude and Elevation</li> <li>Clock &amp; Receiver Status</li> <li>1PPS (input) Deviation</li> <li>Event Time</li> </ul>                               |
| 8     | Status LEDs                        | Operate (Green), Unlocked (Red)                                                                                                                                                                                                                  |
| 9     | Timing Accuracy                    | GPS / UTC time $\pm 1 \mu s$                                                                                                                                                                                                                     |
| 10    | Accuracy                           | Less than one microsecond, depending on network load                                                                                                                                                                                             |
| 11    | Output Ports                       | 6 Nos <ul style="list-style-type: none"> <li>Pulse: 1 No (PPS/PPM/PPH - site configurable)</li> <li>IRIG-B: 2 Nos (AM &amp; TTL)</li> <li>LAN: 3 Nos. LAN interface with RJ45 connector (10/100Base-T). Time synch protocol SNTP, NTP</li> </ul> |
| 12    | Antenna Mounting Type              | Pipe mounted                                                                                                                                                                                                                                     |
| 13    | Antenna cable type                 | RG-6 weatherproof, low loss, 15 m provided                                                                                                                                                                                                       |
|       | Time Display Unit (Remote Display) |                                                                                                                                                                                                                                                  |
| 14    | LEDs                               | High Intensity LEDs                                                                                                                                                                                                                              |
| 15    | Character Size / No. of Characters | 4" (100mm) / 6                                                                                                                                                                                                                                   |
| 16    | Interface                          | The BNC Serial interface with a cable between display unit and receiver. (Length -20 Meter)                                                                                                                                                      |
| 17    | Input connector                    | BNC connector                                                                                                                                                                                                                                    |
| 18    | Industrial Enclosure               | Hang Mounted                                                                                                                                                                                                                                     |
| 19    | Operating Temperature / Humidity   | 0° to 55° C / 0% to 100% Non-condensing                                                                                                                                                                                                          |
| 20    | Power Requirements                 | 90-260 VAC 50/60Hz                                                                                                                                                                                                                               |
| 21    | Accessories                        | Rack mounting kit, Power Cord & Operation Manual                                                                                                                                                                                                 |

## 12. MANAGED SWITCH

| S.No. | Equipment         | Specification                                                                                                                                     |
|-------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Make              | Hirschman /Ruggedcom                                                                                                                              |
| 2     | Type              | Modular Managed                                                                                                                                   |
| 3     | Connector Type    | MTRJ / ST / LC / RJ45                                                                                                                             |
| 4     | Network Speed     | 10/100 Mbps                                                                                                                                       |
| 5     | No of Ports       | As per the approved architecture                                                                                                                  |
| 6     | Auxiliary Voltage | 220V DC                                                                                                                                           |
| 7     | Features          | Graphic user interface, 802.1p QoS Prioritization<br>Tag Base VLANs, IGMP snooping and IGMP-L2 multicast management<br>Port Security, SNMP V2, V3 |
| 8     | Forwarding Mode   | Store and Forward                                                                                                                                 |
| 9     | Relative Humidity | 5% to 95% (non-condensing)                                                                                                                        |
| 10    | Protocol          | IEC 61850                                                                                                                                         |

### 13. LIU

| S.No. | Equipment             | Specification                                           |
|-------|-----------------------|---------------------------------------------------------|
| 1     | Make                  | ARITECH/GENTECH/IVOENET                                 |
| 2     | Ports                 | 24/12/6                                                 |
| 3     | Port Type             | ST Type Single mode                                     |
| 4     | Product Specification | Loaded with PIGTAILS, Fittings, and related ACCESSORIES |
| 5     | Cable Entry           | Up to 2(From Rear)                                      |
| 6     | Mount                 | Rack/Din rail                                           |

### 14. PLCC MODEM

| S.No. | Equipment                   | Specification                                                                        |
|-------|-----------------------------|--------------------------------------------------------------------------------------|
| 1     | Manufacturer, Type          | DECODE                                                                               |
| 2     | Additional Feature          | Operating frequencies include telephone band: 300 Hz to 3400 Hz extended to 4000 Hz. |
| 3     | Operational characteristics |                                                                                      |
| 4     | Operation                   |                                                                                      |
|       | Modulation Type             | FSK                                                                                  |
|       | Procedure                   | Asynchronous serial                                                                  |
|       | Tx/Rx Baud Rate             | 50, 100, 200, 300, 600, 1200 Baud Rate                                               |
|       | UTI-T Standard              | R35, R37, R38A, R38B, V23                                                            |
|       | Alarm Condition             | On DCD loss or watchdog                                                              |
|       | Transmission Mode           | Full duplex/ Half duplex (point to point or multipoint)                              |
|       | Data format                 | 7 to 9 useful bit                                                                    |
| 5     | DTE interface               | EIA RS232/ITU-T V24-V28 Sub-D 25 / D-9 pin female                                    |
| 6     | Dimension                   | 1U Height, 19" Width                                                                 |
| 8     | Nominal voltage             | 48 V DC                                                                              |

### 15. REDBOX

| S.No. | Equipment           | Specification                                                                  |
|-------|---------------------|--------------------------------------------------------------------------------|
| 1     | Manufacturer        | Hirschman                                                                      |
| 2     | Description         | Managed, Industrial Switch DIN Rail, fanless design. Enhanced Redundancy (PRP) |
| 3     | Connector Type      | RJ45 / LC                                                                      |
| 4     | Communication Ports | 6 x 10/100BASE Tx + 2 x SFP slot Fx (100 Mbit)                                 |
| 5     | Redundancy Function | PRP                                                                            |
| 6     | Industrial Profiles | IEC61850 protocol (MMS Server, Switch Model)                                   |
| 7     | Time Synch          | SNTP Server and Client                                                         |
| 8     | Power Supply        | 110 - 250 VDC (88V - 320 VDC)                                                  |

## II. PROTECTION EQUIPMENTS

### A. TRANSMISSION LINE

#### 1. CURRENT DIFFERENTIAL PROTECTION RELAY for 220 kV CIRCUITS - MAIN – I

| S.No. | Equipment                                                                                                                                                          | Specification                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 1     | Name                                                                                                                                                               | GE T&D India Limited                                                                                                         |
| 2     | Manufacturer type & designation                                                                                                                                    | P545 (Numerical)                                                                                                             |
| 3     | Whether Numerical measurement.                                                                                                                                     | Yes                                                                                                                          |
| 4     | Auxiliary DC Voltage with permissible tolerance                                                                                                                    | 125-250V DC                                                                                                                  |
| 5     | CT input, specify whether selectable at site. Permissible over load.                                                                                               | 1/5A Site Selectable, 4xIn                                                                                                   |
| 6     | PT input with permissible over load.                                                                                                                               | 2xVn                                                                                                                         |
| 7     | Type and no. of measuring elements.                                                                                                                                | 6 Individual measuring elements.                                                                                             |
| 8     | No. of zones.                                                                                                                                                      | 5 Zones                                                                                                                      |
| 9     | Type and no. of starting units.                                                                                                                                    | 6 Individual starting units.                                                                                                 |
| 10    | Maximum operating current for each element                                                                                                                         | 64xIn                                                                                                                        |
| 11    | Max. Reactive reach range<br>First zone element<br>Second zone element<br>Third zone element<br>Fourth (Reverse) zone element<br>Power Swing<br>Load Encroachment  | 1, 50m – 500 Ohms<br>2, 50m – 500 Ohms<br>3, 50m – 500 Ohms<br>4, 50m – 500 Ohms<br>5, 100m – 500 Ohms<br>6, 100m – 500 Ohms |
| 12    | Max. Resistive reach range<br>First zone element<br>Second zone element<br>Third zone element<br>Fourth (Reverse) zone element<br>Power Swing<br>Load Encroachment | 1, 50m – 500 Ohms<br>2, 50m – 500 Ohms<br>3, 50m – 500 Ohms<br>4, 50m – 500 Ohms<br>5, 100m – 200 Ohms<br>6, 100m – 500 Ohms |
| 13    | Minimum and maximum line length in Km for which the fault can be detected.                                                                                         | 10m to 1000KM                                                                                                                |
| 14    | Reset ratio for Distance Protection function                                                                                                                       | Above 95%                                                                                                                    |
| 15    | Reset ratio for SOTF                                                                                                                                               | Above 95%                                                                                                                    |
| 16    | Type of power swing blocking (state type and characteristic)                                                                                                       | Impedance characteristic.                                                                                                    |
| 17    | Operating time range<br>First zone<br>Second zone<br>Third zone<br>Fourth (Reverse) zone element<br>PS Blocking timer<br>PS Deblocking timer                       | 1, 0 – 10sec<br>2, 0 – 10sec<br>3, 0 – 10sec<br>4, 0 – 10sec<br>5, 30m – 1sec<br>6, 100m – 10sec                             |
| 18    | Relay characteristics angle range for<br>Measuring units<br>Starting units<br>Power swing blocking relays                                                          | 1, 0-90 deg<br>2, 0-90 deg<br>3, 20-90 deg                                                                                   |
| 19    | Whether suitable for any communication scheme.                                                                                                                     | Suitable for all carrier aided schemes                                                                                       |
| 20    | Have all carrier auxiliary relays been provided (give technical particulars)                                                                                       | Provided as per scheme                                                                                                       |
| 21    | No. of Binary inputs and their ratings.                                                                                                                            | 24                                                                                                                           |
| 22    | No. of Binary outputs and their ratings.                                                                                                                           | 32                                                                                                                           |
| 23    | Tripping time carrier (maximum and minimum)                                                                                                                        | Setting range 0-1sec                                                                                                         |
| 24    | Type of auto re-close scheme and time range for                                                                                                                    | 1, 0-10sec                                                                                                                   |

|    |                                                                                                                                                                                                     |                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
|    | II. Potential circuit<br>III. DC circuits                                                                                                                                                           | 3, 11 Watts                                                       |
| 26 | Whether continuous self monitoring and diagnostic feature is available                                                                                                                              | Yes                                                               |
| 27 | Relay characteristics possible                                                                                                                                                                      | Quad/MHO                                                          |
| 28 | Change in characteristics possible                                                                                                                                                                  | Yes                                                               |
| 29 | Burden on CT and VT per phase.                                                                                                                                                                      | Current: < 0.2 VA<br>Voltage: < 0.1 VA                            |
| 30 | i) No. of tripping relays provided<br>ii) No. of NO/NC contacts of each tripping relays suitable for use in auto reclosure scheme.                                                                  | i) Yes<br>ii) Provided as per scheme                              |
| 31 | All aux. relay for the scheme provided.                                                                                                                                                             | Provided as per scheme                                            |
| 32 | All external resistors as required provided.                                                                                                                                                        | NA                                                                |
| 33 | Carrier ON/OFF provided.                                                                                                                                                                            | Yes                                                               |
| 34 | Auto re-closure scheme with check relay as per specification in annexure III                                                                                                                        | Part of BCU                                                       |
| 35 | Measurements of functions list here.                                                                                                                                                                | Current, Voltage & Power                                          |
| 36 | No. of Disturbance Records and their different time periods.                                                                                                                                        | 50 – Settable Timer from 100m-10sec                               |
| 37 | Manual online testing facility provided through test plug without isolation of any circuit from panel TB                                                                                            | Yes                                                               |
| 38 | Communication protocols                                                                                                                                                                             | IEC 61850                                                         |
| 39 | Time Synchronization                                                                                                                                                                                | SNTP                                                              |
| 40 | Is the scheme exactly as per specification                                                                                                                                                          | Yes                                                               |
|    |                                                                                                                                                                                                     |                                                                   |
|    |                                                                                                                                                                                                     |                                                                   |
|    | <b>LINE DIFFERENTIAL PROTECTION RELAY</b>                                                                                                                                                           |                                                                   |
| 42 | The relay shall have all the feature as per Distance protection relay                                                                                                                               | Yes                                                               |
| 43 | It shall be working on phase segregated current Differential protection principle                                                                                                                   | Yes                                                               |
| 44 | It shall have multiple slope characteristics (preferably) to have stability against CT saturation and heavy through faults as well as sensitivity for internal faults                               | Yes                                                               |
| 45 | It shall measure Differential as well as restrain current continuously and shall display the same as measurement                                                                                    | Yes                                                               |
| 46 | It shall use fiber optic cable or multiplexed digital network to exchange telegrams                                                                                                                 | Yes                                                               |
| 47 | It shall communicate to remote end through IEEE C37.94 format                                                                                                                                       | Yes                                                               |
| 48 | It shall have redundant communication channels for protection communication                                                                                                                         | Yes                                                               |
| 49 | It shall communication analogue as well as digital signals to remote end.                                                                                                                           | Yes                                                               |
| 50 | It shall have various communication options for remote communication i.e mono-mode / multi-mode for direct communication / communication through multiplexer                                        | Selectable based on line length<br>1300nm – single mode selected. |
| 51 | It shall have Line charging current compensation feature for better sensitivity                                                                                                                     | Yes                                                               |
| 52 | Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication                                                     | Yes                                                               |
| 53 | It shall communicate time coordinated current signals for remote communication to execute Line differential protection algorithm accurately time synchronization through GPS shall also be possible | Yes                                                               |

|    |                                                                                                                                               |                                     |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| 54 | It shall monitor individual communication links continuously and switchover to standby link after present time in case of failure of one link | Yes                                 |
| 55 | It shall supervise individual telegrams                                                                                                       | Yes                                 |
| 56 | It shall detect reflected telegrams                                                                                                           | Yes                                 |
| 57 | It shall detect change in communication delay time                                                                                            | Yes                                 |
| 58 | It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm                   | Yes                                 |
| 59 | It shall also supervise maximum permissible delay time                                                                                        | Yes                                 |
| 60 | It shall generate alarm for heavily disturbed communication link                                                                              | Yes                                 |
|    |                                                                                                                                               |                                     |
|    | <b>DIFFERENTIAL PROTECTION SETTING</b>                                                                                                        |                                     |
| 61 | Minimum operating current                                                                                                                     | 100mA – 2A                          |
| 62 | Slope (Single/dual)                                                                                                                           | Dual                                |
| 63 | End section (Single / dual)                                                                                                                   | Dual                                |
| 64 | High set operating current                                                                                                                    | 100mA – 32A                         |
| 65 | 2 <sup>nd</sup> Harmonic blocking                                                                                                             | Yes                                 |
| 66 | Typical operating time                                                                                                                        | < 35mS                              |
| 67 | Operating time for high set                                                                                                                   | ± 2% or 2ms whichever is greater.   |
| 68 | Charging current compensation                                                                                                                 | Yes                                 |
|    |                                                                                                                                               |                                     |
|    | <b>REMOTE COMMUNICATION</b>                                                                                                                   |                                     |
| 71 | Nos. of Analogue signal transfer                                                                                                              | R,Y,B - Phase current               |
| 72 | Nos. of Binary signal transfer                                                                                                                | 16 Signals                          |
| 73 | Dual Remote Communication module<br>a) 1300 nm – multi-mode OR<br>b) 1300 / 1500 nm – mono-mode                                               | 1300nm – Single mode                |
| 74 | Synchronization mode<br>GPS<br>ECHO                                                                                                           | Both available                      |
| 75 | Time delay alarm for communication fail                                                                                                       | 100m – 600 sec                      |
| 76 | Time delay for switching to redundant channel                                                                                                 | Both channels will work parallel    |
| 77 | Asymmetric delay (For echo mode)                                                                                                              | 400ms to 30 secs                    |
| 78 | Max. Transmission delay time                                                                                                                  | 250 micro seconds to 1 milli second |

## 2. CURRENT DIFFERENTIAL PROTECTION RELAY for 220 kV CIRCUITS - MAIN – II

| S.No. | Equipment                                                                                                                                                          | Specification                                                                                                               |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 1     | Name                                                                                                                                                               | GE Multilin,                                                                                                                |
| 2     | Manufacturer type & designation                                                                                                                                    | L90 (Numerical)                                                                                                             |
| 3     | Whether Numerical measurement.                                                                                                                                     | Yes                                                                                                                         |
| 4     | Auxiliary DC Voltage with permissible tolerance                                                                                                                    | 125-250 Vdc                                                                                                                 |
| 5     | CT input, specify whether selectable at site. Permissible over load.                                                                                               | 1/5A Site Selectable, 4xIn                                                                                                  |
| 6     | PT input with permissible overload.                                                                                                                                | 260 V Continuous to neutral                                                                                                 |
| 7     | Type and no. of measuring elements.                                                                                                                                | 6 Individual measuring elements.                                                                                            |
| 8     | No. of zones.                                                                                                                                                      | 5 Zones                                                                                                                     |
| 9     | Type and no. of starting units.                                                                                                                                    | 6 Individual starting units.                                                                                                |
| 10    | Maximum operating current for each element                                                                                                                         | 46xIn                                                                                                                       |
| 11    | Max. Reactive reach range<br>First zone element<br>Second zone element<br>Third zone element<br>Fourth (Reverse) zone element<br>Power Swing<br>Load Encroachment  | 1, 20m – 500 Ohms<br>2, 20m – 500 Ohms<br>3, 20m – 500 Ohms<br>4, 20m – 500 Ohms<br>5, 100m – 500 Ohms<br>6, 20m – 250 Ohms |
| 12    | Max. Resistive reach range<br>First zone element<br>Second zone element<br>Third zone element<br>Fourth (Reverse) zone element<br>Power Swing<br>Load Encroachment | 1, 20m – 500 Ohms<br>2, 20m – 500 Ohms<br>3, 20m – 500 Ohms<br>4, 20m – 500 Ohms<br>5, 100m – 500 Ohms<br>6, 20m – 250 Ohms |
| 13    | Minimum and maximum line length in Km for which the fault can be detected.                                                                                         | 0-2000km                                                                                                                    |
| 14    | Reset ratio for Distance Protection function                                                                                                                       | Above 95%                                                                                                                   |
| 15    | Reset ratio for SOTF                                                                                                                                               | Above 95%                                                                                                                   |
| 16    | Type of power swing blocking (state type and characteristic)                                                                                                       | Impedance characteristic                                                                                                    |
| 17    | Operating time range<br>First zone<br>Second zone<br>Third zone<br>Fourth (Reverse) zone element<br>PS Blocking timer<br>PS Deblocking timer                       | 1, 0 – 65sec<br>2, 0 – 65sec<br>3, 0 – 65sec<br>4, 0 – 65sec<br>5, 0 – 65sec<br>6, 0 – 65sec                                |
| 18    | Relay characteristics angle range for<br>Measuring units<br>Starting units<br>Power swing blocking relays                                                          | 1, 30-90 deg<br>2, 30-90 deg<br>3, 40-140 deg                                                                               |
| 19    | Whether suitable for any communication scheme.                                                                                                                     | Suitable for all carrier aided schemes                                                                                      |
| 20    | Have all carrier auxiliary relays been provided (give technical particulars)                                                                                       | Provided as per scheme                                                                                                      |
| 21    | No. of Binary inputs and their ratings.                                                                                                                            | 24                                                                                                                          |
| 22    | No. of Binary outputs and their ratings.                                                                                                                           | 28                                                                                                                          |
| 23    | Tripping time carrier (maximum and minimum)                                                                                                                        | Setting range 0-65 sec                                                                                                      |
| 24    | Type of auto re-close scheme and time range for<br>III. Dead time<br>IV. Reclaim time                                                                              | 1, 0-655sec<br>2, 0-655sec                                                                                                  |
| 25    | VA burden of each phase relay<br>IV. Current circuit<br>V. Potential circuit<br>VI. DC circuits                                                                    | 1, < 0.2 VA<br>2, < 0.25 VA<br>3, 20 Watts                                                                                  |
| 26    | Whether continuous self monitoring and diagnostic feature is available                                                                                             | Yes                                                                                                                         |
| 27    | Relay characteristics possible                                                                                                                                     | Quad/MHO                                                                                                                    |



|    |                                                                                                                                                                                                     |                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| 28 | Change in characteristics possible                                                                                                                                                                  | Yes                                                               |
| 29 | Burden on CT and VT per phase.                                                                                                                                                                      | Current: < 0.2 VA<br>Voltage: < 0.25 VA                           |
| 30 | i) No. of tripping relays provided<br>ii) No. of NO/NC contacts of each tripping relays suitable for use in auto reclosure scheme.                                                                  | i) Yes<br>ii) Provided as per scheme                              |
| 31 | All aux. relay for the scheme provided.                                                                                                                                                             | Provided as per scheme                                            |
| 32 | All external resistors as required provided.                                                                                                                                                        | NA                                                                |
| 33 | Carrier ON/OFF provided.                                                                                                                                                                            | Yes                                                               |
| 34 | Auto re-closure scheme with check relay as per specification in annexure III                                                                                                                        | Part of BCU                                                       |
| 35 | Measurements of functions list here.                                                                                                                                                                | Current, Voltage & Power                                          |
| 36 | No. of Disturbance Records and their different time periods.                                                                                                                                        | 128                                                               |
| 37 | Manual online testing facility provided through test plug without isolation of any circuit from panel TB                                                                                            | Yes                                                               |
| 38 | Communication protocols                                                                                                                                                                             | IEC 61850                                                         |
| 39 | Time Synchronization                                                                                                                                                                                | SNTP                                                              |
| 40 | Is the scheme exactly as per specification                                                                                                                                                          | Yes                                                               |
|    |                                                                                                                                                                                                     |                                                                   |
|    | <b>LINE DIFFERENTIAL PROTECTION RELAY</b>                                                                                                                                                           |                                                                   |
| 41 | The relay shall have all the feature as per Distance protection relay                                                                                                                               | Yes                                                               |
| 42 | It shall be working on phase segregated current Differential protection principle                                                                                                                   | Yes                                                               |
| 43 | It shall have multiple slope characteristics (preferably) to have stability against CT saturation and heavy through faults as well as sensitivity for internal faults                               | Yes                                                               |
| 44 | It shall measure Differential as well as restrain current continuously and shall display the same as measurement                                                                                    | Yes                                                               |
| 45 | It shall use fiber optic cable or multiplexed digital network to exchange telegrams                                                                                                                 | Yes                                                               |
| 46 | It shall communicate to remote end through IEEE C37.94 format                                                                                                                                       | Yes                                                               |
| 47 | It shall have redundant communication channels for protection communication                                                                                                                         | Yes                                                               |
| 48 | It shall communication analogue as well as digital signals to remote end.                                                                                                                           | Yes                                                               |
| 49 | It shall have various communication options for remote communication i.e mono-mode / multi-mode for direct communication / communication through multiplexer                                        | Selectable based on line length<br>1310nm – single mode selected. |
| 50 | It shall have Line charging current compensation feature for better sensitivity                                                                                                                     | Yes                                                               |
| 51 | Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication                                                     | Yes                                                               |
| 52 | It shall communicate time coordinated current signals for remote communication to execute Line differential protection algorithm accurately time synchronization through GPS shall also be possible | Yes                                                               |
| 53 | It shall monitor individual communication links continuously and switchover to standby link after present time in case of failure of one link                                                       | Yes                                                               |
| 54 | It shall supervise individual telegrams                                                                                                                                                             | Yes                                                               |
| 55 | It shall detect reflected telegrams                                                                                                                                                                 | Yes                                                               |
| 56 | It shall detect change in communication delay time                                                                                                                                                  | Yes                                                               |

|    |                                                                                                                             |                                  |
|----|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 57 | It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm | Yes                              |
| 58 | It shall also supervise maximum permissible delay time                                                                      | Yes                              |
| 59 | It shall generate alarm for heavily disturbed communication link                                                            | Yes                              |
|    |                                                                                                                             |                                  |
|    | <b>DIFFERENTIAL PROTECTION SETTING</b>                                                                                      |                                  |
| 61 | Minimum operating current                                                                                                   | 0.1 PU to 4 PU                   |
| 62 | Slope (Single/dual)                                                                                                         | Dual                             |
| 63 | End section (Single / dual)                                                                                                 | Dual                             |
| 64 | High set operating current                                                                                                  | 0 to 90 PU                       |
| 65 | 2 <sup>nd</sup> Harmonic blocking                                                                                           | Yes                              |
| 66 | Typical operating time                                                                                                      | 30Ms                             |
| 67 | Operating time for high set                                                                                                 | 0 to 65 secs                     |
| 68 | Charging current compensation                                                                                               | Yes                              |
|    |                                                                                                                             |                                  |
|    | <b>REMOTE COMMUNICATION</b>                                                                                                 |                                  |
| 71 | Nos. of Analogue signal transfer                                                                                            | R,Y,B,N currents                 |
| 72 | Nos. of Binary signal transfer                                                                                              | 8 signals per channel            |
| 73 | Dual Remote Communication module<br>a) 1300 nm – multi-mode OR<br>b) 1300 / 1500 nm – mono-mode                             | 1310 Mono mode                   |
| 74 | Synchronization mode<br>GPS<br>ECHO                                                                                         | GPS                              |
| 75 | Time delay alarm for communication fail                                                                                     | Yes                              |
| 76 | Time delay for switching to redundant channel                                                                               | Both channels will work parallel |
| 77 | Asymmetric delay (For echo mode)                                                                                            | 10mS                             |
| 78 | Max. Transmission delay time                                                                                                | 0 to 10 milli seconds            |
|    |                                                                                                                             |                                  |

### 3. GRID ISLAND PROTECTION

| S.No. | Equipment                         | Specification                                    |
|-------|-----------------------------------|--------------------------------------------------|
| 1     | Name and country of Manufacturer  | GE T&D India Limited                             |
| 2     | Manufacturer type and designation | P341 (Numerical)                                 |
| 3     | Frequency Protection              |                                                  |
|       | Under / Over Frequency            | Available                                        |
|       | Pick-up:                          | Setting $\pm 0.01\text{Hz}$                      |
|       | Drop-off:                         | (Setting $+0.025\text{Hz}$ ) $\pm 0.01\text{Hz}$ |
| 4     | Rate of change of frequency       | Available                                        |
|       | Pickup                            | Setting $\pm 0.5\text{Hz/s}$                     |
| 5     | Power Protection                  |                                                  |
|       | Active/Reactive power             | Available                                        |
|       | Pick-up:                          | Setting $\pm 5\%$                                |
|       | Operating time:                   | $\pm 2\%$ or 50ms whichever is greater           |
| 6     | Vector Surge Protection           | Available                                        |
|       |                                   | V Shift Angle: 2...30 Deg                        |
| 7     | Voltage Based Protection          | Available                                        |
| 8     | Type of relay                     | Triple pole Numerical relay                      |
| 9     | Communication                     | IEC 61850                                        |
| 10    | Nominal Current                   | 1A / 5A                                          |
| 11    | Whether DR is provided?           | Yes (Inbuilt)                                    |
| 12    | Scan Rate                         | 1200Hz                                           |

## B. TRANSFORMER PROTECTION

### 1. DIFFERENTIAL PROTECTION FOR 220/33 kV TRANSFORMER – Main -1 & Main-2

| S.No. | Equipment                                                                                                     | Specification                                                  |
|-------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                                                              | GE T&D India Limited                                           |
| 2     | Manufacturer type and designation                                                                             | P643 (Numerical)                                               |
| 3     | Whether three instantaneous units Provided?                                                                   | Yes                                                            |
| 4     | Whether continuous self-monitoring and diagnostic feature is available                                        | Yes                                                            |
| 5     | Current circuit rating                                                                                        | 1A or 5A                                                       |
| 6     | Voltage circuit rating                                                                                        | 100 V to 120 V                                                 |
| 7     | Operating Principle                                                                                           | Current Differential Principle                                 |
| 8     | Max. V.A burden                                                                                               |                                                                |
|       | i) Operating Circuit                                                                                          | < 0.01VA                                                       |
|       | ii) Restraining Circuit                                                                                       | < 0.01VA                                                       |
| 9     | Min. Operating Current                                                                                        |                                                                |
| 10    | Whether Second and Fifth harmonic restraint feature provided?                                                 | Yes                                                            |
| 11    | Operating current setting range                                                                               | 10% - 250% in steps of 1%                                      |
| 12    | Bias setting range                                                                                            | Slope - 1: 0 to 150%<br>Slope - 2: 15 to 150%                  |
| 13    | Operating time at 5x rated current                                                                            | <30 ms                                                         |
| 14    | Resetting time                                                                                                | Less than 15 ms                                                |
| 15    | How ratio / phase angle corrections are being done (inter posing transformer / internal feature in the relay) | In built feature in the relay                                  |
| 16    | Adjustable Bias setting                                                                                       | 0-150%                                                         |
| 17    | Three Pole instantaneous high set units provided                                                              | Yes                                                            |
| 18    | Burden on Purchaser's CT                                                                                      | < 0.01VA                                                       |
| 19    | Output contact rating                                                                                         | 10 A, 300 V                                                    |
| 20    | Shall have the following function                                                                             |                                                                |
|       | i) Differential Protection                                                                                    | Yes                                                            |
|       | ii) Restriction Earth Fault Protection                                                                        | Yes                                                            |
|       | iii) Thermal Over Load Detection                                                                              | Yes                                                            |
|       | iv) Over Fluxing Protection                                                                                   | Yes                                                            |
|       | v) LBB                                                                                                        | Yes                                                            |
| 21    | Type of relay                                                                                                 | Triple pole Numerical relay                                    |
| 22    | Whether DR is provided?                                                                                       | Yes (Inbuilt)                                                  |
| 23    | Communication<br>a, Type of Port (Front)<br>b, Type of Port (Rear)<br>c, Comm. Protocol<br>d, Time sync port  | a, RS232<br>b, RS232 / RS485 / KBus<br>c, IEC 61850<br>d, SNTP |

## 2. RESTRICTED EARTH FAULT PROTECTION – HV REF

| S.No. | Equipment                                                                 | Specification                                                                                                                                                                                            |
|-------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                          | GE T&D India Limited                                                                                                                                                                                     |
| 2     | Manufacturer type and designation                                         | P643 (Numerical) – Built in Diff Protection Main - 1                                                                                                                                                     |
| 3     | Maximum VA Burden                                                         | < 0.01VA                                                                                                                                                                                                 |
| 4     | Operating time                                                            |                                                                                                                                                                                                          |
|       | i) Minimum                                                                | <25 ms                                                                                                                                                                                                   |
|       | ii) Maximum                                                               | <30 ms                                                                                                                                                                                                   |
| 5     | No of contact make & carry for 0.5 sec and break type                     | All contacts                                                                                                                                                                                             |
| 6     | Whether contacts self-reset or hand reset.                                | Configurable                                                                                                                                                                                             |
| 7     | Contact ratings                                                           |                                                                                                                                                                                                          |
|       | i) Make and carry continuously                                            | 10A                                                                                                                                                                                                      |
|       | ii) Make and carry for 0.5 sec.                                           | 30A for 3 sec                                                                                                                                                                                            |
|       | iii) Break resistive load and inductive load with 40m. sec. time current. | 4 A for 1.5 s, 10000 operations (subject to the above limit for make and break, dc resistive load)<br>0.5 A for 1 s, 10000 operations (subject to the above limit for make and break, dc inductive load) |
| 8     | Setting Range (Earth fault unit)                                          |                                                                                                                                                                                                          |
|       | a) Inverse Definite Minimum Time                                          | 2% to 400% of In                                                                                                                                                                                         |
|       | b) High set inst. Unit                                                    | -                                                                                                                                                                                                        |
|       | c) Characteristic Angle                                                   | -                                                                                                                                                                                                        |

## 3. RESTRICTED EARTH FAULT PROTECTION – LV REF

| S.No. | Equipment                                                                 | Specification                                                                                                                                                                                            |
|-------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                          | GE T&D India Limited                                                                                                                                                                                     |
| 2     | Manufacturer type and designation                                         | P141 (Numerical)                                                                                                                                                                                         |
| 3     | Maximum VA Burden                                                         | < 0.2VA                                                                                                                                                                                                  |
| 4     | Operating time                                                            |                                                                                                                                                                                                          |
|       | i) Minimum                                                                | <25 ms                                                                                                                                                                                                   |
|       | ii) Maximum                                                               | <30 ms                                                                                                                                                                                                   |
| 5     | No of contact make & carry for 0.5 sec and break type                     | All contacts                                                                                                                                                                                             |
| 6     | Whether contacts self-reset or hand reset.                                | Self-reset                                                                                                                                                                                               |
| 7     | Contact ratings                                                           |                                                                                                                                                                                                          |
|       | i) Make and carry continuously                                            | 10A                                                                                                                                                                                                      |
|       | ii) Make and carry for 0.5 sec.                                           | 30A for 3 sec                                                                                                                                                                                            |
|       | iii) Break resistive load and inductive load with 40m. sec. time current. | 4 A for 1.5 s, 10000 operations (subject to the above limit for make and break, dc resistive load)<br>0.5 A for 1 s, 10000 operations (subject to the above limit for make and break, dc inductive load) |
| 8     | Setting Range (Earth fault unit)                                          |                                                                                                                                                                                                          |
|       | a) Inverse Definite Minimum Time                                          | 2% to 400% of In                                                                                                                                                                                         |
|       | b) High set inst. Unit                                                    | -                                                                                                                                                                                                        |
|       | c) Characteristic Angle                                                   | -                                                                                                                                                                                                        |

#### 4. OVERFLUX PROTECTION – HV & LV Side

| S.No. | Equipment                                                      | Specification                                                                                                                                |
|-------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Name and country of Manufacturer                               | GE T&D India Limited                                                                                                                         |
| 2     | Manufacturer type and designation                              | HV Side: P643 (Numerical) - Built in Differential Protection Main -1<br>LV Side: P643 (Numerical) - Built in Differential Protection Main -2 |
| 3     | Rating (V/Hz)                                                  | 110V, 50Hz                                                                                                                                   |
| 4     | Principle of operation                                         | Voltage to Frequency ratio                                                                                                                   |
| 5     | Setting Range                                                  | 1.05 to 2 Pu                                                                                                                                 |
| 6     | No of Stages in relay                                          | 4 Stages                                                                                                                                     |
| 7     | No. of timers provided and range of time settings available.   | 0 to 6000 sec                                                                                                                                |
| 8     | Burden                                                         | < 0.06VA                                                                                                                                     |
| 9     | Auxiliary relays as necessary to make scheme complete provided | Not applicable                                                                                                                               |
| 10    | No. and rating of protective and auxiliary relay contact       | Not applicable                                                                                                                               |

#### 5. BACK UP DIRECTIONAL O/C & E/F PROTECTION

| S.No. | Equipment                                                                                                                                                                                                                                                             | Specification                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| 1     | Name and country of Manufacturer                                                                                                                                                                                                                                      | GE T&D India Limited                                |
| 2     | Manufacturer type and designation                                                                                                                                                                                                                                     | P643 (Numerical) - Built in Differential Protection |
| 3     | Whether Numerical and have true RMS measurement.                                                                                                                                                                                                                      | Yes                                                 |
| 4     | Display type for HMI                                                                                                                                                                                                                                                  | LCD                                                 |
| 5     | Give the details of self monitoring (Hardware & software) and indication/ alarm facility on internal relay failure                                                                                                                                                    | Yes                                                 |
| 6     | <ul style="list-style-type: none"> <li>Current input (CT Secondary)</li> <li>Whether selectable from front panel at site</li> </ul>                                                                                                                                   | 1/5A selectable                                     |
| 7     | Auxiliary Supply and its burden with permissible tolerance                                                                                                                                                                                                            | 110-250V DC, 11Watts                                |
| 8     | No. of poles                                                                                                                                                                                                                                                          | 3 Poles                                             |
| 9     | Current Setting range for Over Current element                                                                                                                                                                                                                        | 80mA to 4A IDMT                                     |
| 10    | Current Setting range for Earth fault element                                                                                                                                                                                                                         | 80mA to 4A IDMT                                     |
| 11    | <ul style="list-style-type: none"> <li>Type of characteristics available</li> <li>Whether selectable from front panel at site</li> </ul>                                                                                                                              | 1, All IEC Curves<br>2, Selectable                  |
| 12    | High set current setting range for Over current                                                                                                                                                                                                                       | 80mA to 32A High set                                |
| 13    | High set current setting range for Earth Fault                                                                                                                                                                                                                        | 80mA to 32A High set                                |
| 14    | Time multiplier                                                                                                                                                                                                                                                       | 0.025 to 1.2 TMS                                    |
| 15    | Reset Ratio                                                                                                                                                                                                                                                           | Above 95%                                           |
| 16    | <b>Built-in Breaker Failure Protection</b> <ol style="list-style-type: none"> <li>Current Setting range</li> <li>Time range</li> <li>No. of poles</li> <li>Operating time</li> <li>Resetting time</li> <li>No. of O/P Contacts available for this feature.</li> </ol> | Not Applicable                                      |
| 17    | Burden at CT inputs                                                                                                                                                                                                                                                   | < 0.01VA                                            |
| 18    | <ul style="list-style-type: none"> <li>No. of fault event can be stored</li> <li>Type of data stored on fault</li> </ul>                                                                                                                                              | 1, 512 Event<br>2, All Trip & Alarm events          |
| 19    | Maximum duration for DR on each fault                                                                                                                                                                                                                                 | 10.5 Sec                                            |
| 20    | No. of Binary inputs                                                                                                                                                                                                                                                  | 24                                                  |
| 21    | No. of Binary outputs. (trip/ signaling)                                                                                                                                                                                                                              | 16                                                  |

|    |                                                                                                                                                                                                         |                                                                |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 22 | Contact rating<br>I. Make and carry continuously<br>II. Make and carry for 0.5 sec.<br>III. Break resistive load and inductive load with 40m sec. time constant<br>IV. Whether self reset or hand reset | 1, 10A<br>2, 30A for 3 sec<br>3, 62.5 Watts<br>4, Selectable.  |
| 23 | Communication<br>a) Type of port (front)<br>b) Type of port (Rear)<br>c) Comm. Protocol<br>d) Time sync port                                                                                            | a, RS232<br>b, RS232 / RS485 / KBus<br>c, IEC 61850<br>d, SNTP |

## 6. SEF PROTECTION - HV

| S.No. | Equipment                                                        | Specification                                               |
|-------|------------------------------------------------------------------|-------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                 | GE T&D India Limited                                        |
| 2     | Manufacturer type and designation                                | P643 (Numerical) - Built in Differential Protection Main -2 |
| 3     | Overcurrent unit setting range                                   |                                                             |
|       | a) Inverse Definite Minimum Time                                 | 8 – 400% of In                                              |
|       | b) High set inst. Unit                                           | 8 – 3200% of In                                             |
|       | c) Characteristic Angle                                          | - 95 ° to +95 °                                             |
| 4     | Earth fault unit setting range                                   |                                                             |
|       | a) Inverse Definite Minimum Time                                 | 8 – 400% of In                                              |
|       | b) High set inst. Unit                                           | 8 – 3200% of In                                             |
|       | c) Characteristic Angle                                          | - 95 ° to +95 °                                             |
| 5     | Minimum operation time for Over Current & Earth Fault Protection | IDMT curve operation time ±5% or 40ms whichever is greater  |

## 7. SEF PROTECTION – LV

| S.No. | Equipment                                                        | Specification                                              |
|-------|------------------------------------------------------------------|------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                 | GE T&D India Limited                                       |
| 2     | Manufacturer type and designation                                | P141 (Numerical) - Built in LV REF Protection              |
| 3     | Earth fault unit setting range                                   |                                                            |
|       | a) Inverse Definite Minimum Time                                 | 5 – 400% of In                                             |
|       | b) High set inst. Unit                                           | 5 – 3200% of In                                            |
|       | c) Characteristic Angle                                          | - 95 ° to +95 °                                            |
| 4     | Minimum operation time for Over Current & Earth Fault Protection | IDMT curve operation time ±5% or 40ms whichever is greater |



## C. BUSBAR & LBB PROTECTION

### 1. BUSBAR PROTECTION – DISTRIBUTED SCHEME

| S.No. | Equipment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Specification                                                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | GE T&D India Limited                                                                                                                                                                                                                                                                                                     |
| 2     | Manufacturer type and designation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | P741 (Numerical) - Central Unit<br>P743 (Numerical) - Peripheral Unit                                                                                                                                                                                                                                                    |
| 3     | <b>Bus Bar protection Functions:</b> <ol style="list-style-type: none"> <li>1. Min fault current pick-up range (Ik min)</li> <li>2. Neutral current Detection range</li> <li>3. Stabilizing factor (K)</li> <li>4. Diff current Alarm S=setting range</li> <li>5. Time Delay for (4) above</li> <li>6. Isolator alarm time delay setting</li> <li>7. Typical tripping time</li> </ol>                                                                                                                                                                                                                    | <ol style="list-style-type: none"> <li>1. 50mA to 30A</li> <li>2. 10mA to 30A</li> <li>3. 20 to 90%</li> <li>4. 10mA to 500mA</li> <li>5. 100ms to 600sec</li> <li>6. 0 to 14000 secs</li> <li>7. 13ms typical</li> </ol>                                                                                                |
| 4     | <b>Check Zone:</b> <ol style="list-style-type: none"> <li>1. Min fault current pick-up range (Ik min)</li> <li>2. Stabilizing factor (K)</li> <li>3. CT Ratio matching range</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                  | <ol style="list-style-type: none"> <li>1. 50mA to 30 A</li> <li>2. 0 to 90%</li> <li>3. UPTO 40 TIMES</li> </ol>                                                                                                                                                                                                         |
| 5     | <b>Analog inputs (Bay or peripheral or Field Unit):</b> <ol style="list-style-type: none"> <li>1. Maximum no. of Bays which can be connected with central unit</li> <li>2. Current Rating</li> <li>3. Thermal Ratings:<br/>Continuous<br/>For 10 s, Minimum 10xIn<br/>For 1 s, 100xIn</li> <li>4. Auxiliary Supply</li> </ol>                                                                                                                                                                                                                                                                            | <ol style="list-style-type: none"> <li>1. 28 bays</li> <li>2. 1A/5A</li> <li>3. Continuous – 4 times In.<br/>30A for 3 secs<br/>100A for 1 secs</li> <li>4. Aux supply: 125 – 250V DC</li> </ol>                                                                                                                         |
| 6     | <b>Binary Inputs/ Outputs:</b> <ol style="list-style-type: none"> <li>1. Operating Time</li> <li>2. Max Operating Volt</li> <li>3. Max Cont rating</li> <li>4. Max make &amp; carry</li> <li>5. Max making power</li> <li>6. Whether Binary O/P Reset Programmable</li> <li>7. Breaking Current:<br/>Heavy Duty N/O Contact:<br/>Signaling Contact:</li> <li>8. No. of I/P per bay unit:</li> <li>9. No. of I/P for central unit:</li> <li>10. Pickup current for I/p:</li> <li>11. Operating Time for I/P:</li> <li>12. Nos of Output _ Bay unit:</li> <li>13. Nos of output _ Central Unit:</li> </ol> | <ol style="list-style-type: none"> <li>1. Contact operating time = 200micro secs</li> <li>2. 300V</li> <li>3. Continuous = 10A</li> <li>4. 30A for 3 secs</li> <li>5. 62.5W</li> <li>6. Yes</li> <li>7. 10A</li> <li>8. 24</li> <li>9. 8</li> <li>10. &lt;5MA</li> <li>11. 7ms</li> <li>12. 16</li> <li>13. 8</li> </ol> |
| 7     | <b>Auxiliary Supply:</b> <ol style="list-style-type: none"> <li>1. Input Voltage:</li> <li>2. Load: (Bay Unit)<br/>(Central Unit)</li> <li>3. Front plate signal</li> <li>4. Switch</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                           | <ol style="list-style-type: none"> <li>1. 125V to 250V DC</li> <li>2. Bay unit = 22 to 32 W<br/>Central unit = 37 to 41 W</li> <li>3. LEDs</li> <li>4. NA</li> </ol>                                                                                                                                                     |
| 8     | <b>Optical Interface:</b> <ol style="list-style-type: none"> <li>1. Number of cores</li> <li>2. Core/ sheath diameter</li> <li>3. Max permissible attenuation</li> <li>4. Connector</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                           | <ol style="list-style-type: none"> <li>1. Two Core patch chord.</li> <li>2. 2MM DIA, Low Smoke Zero Halogen</li> <li>3. 850nm</li> <li>4. ST/ST</li> </ol>                                                                                                                                                               |
| 9     | <b>Event Recorder:</b><br>It shall have event recording facility for minimum last 50 Operational / fault events.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <ol style="list-style-type: none"> <li>1. 512 events</li> </ol>                                                                                                                                                                                                                                                          |
| 10    | <b>Disturbance Recorder:</b> <ol style="list-style-type: none"> <li>1. Independent setting for pre-fault and post-fault period</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ol style="list-style-type: none"> <li>1. 100ms to 10.5 secs</li> <li>2. Comtrade</li> </ol>                                                                                                                                                                                                                             |

|    |                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                 |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 11 | <b>Local &amp; Remote communication:</b> <ol style="list-style-type: none"> <li>1. Serial interface for connecting a PC, either directly or via a modem.</li> <li>2. System interface for connecting to a control system via IEC 61850.</li> <li>3. System interface via IEC 61850 protocol for inter bay bus supports.</li> <li>4. Time synchronization via IRIG-B / SNTP</li> </ol> | <ol style="list-style-type: none"> <li>1. RS232/USB</li> <li>2. Fiber optic or RJ45</li> <li>3. Fiber optic or RJ45</li> <li>4. SNTP</li> </ol> |
| 12 | Communication ports: <ul style="list-style-type: none"> <li>• Front _ RS232 / RJ45 / Optical</li> <li>• Rear – Fiber optic / RJ45</li> </ul>                                                                                                                                                                                                                                          | yes                                                                                                                                             |
| 13 | Maximum fault current for which 100% stability can be achieved                                                                                                                                                                                                                                                                                                                        | 64 times In                                                                                                                                     |
| 14 | Impedance type and operating characteristic                                                                                                                                                                                                                                                                                                                                           | Low impedance type                                                                                                                              |
| 15 | Continuous supervision of CT secondary against open circuit                                                                                                                                                                                                                                                                                                                           | Yes                                                                                                                                             |
| 16 | Architecture & interconnection of CT secondary against open circuit                                                                                                                                                                                                                                                                                                                   | Yes                                                                                                                                             |
| 17 | Principle of CT ration error matching                                                                                                                                                                                                                                                                                                                                                 | CT error adjusted through pick up setting                                                                                                       |
| 18 | Measure and tripping criterion                                                                                                                                                                                                                                                                                                                                                        | Numerical                                                                                                                                       |
| 19 | HMI details                                                                                                                                                                                                                                                                                                                                                                           | 16X3 LCD display                                                                                                                                |
| 20 | Self supervision and diagnostic facility.                                                                                                                                                                                                                                                                                                                                             | Yes                                                                                                                                             |
| 21 | Measurements available                                                                                                                                                                                                                                                                                                                                                                | Yes                                                                                                                                             |
| 22 | Whether bus bar image for each bay is formed and displayed in HMI                                                                                                                                                                                                                                                                                                                     | Busbar image can be seen in PC only                                                                                                             |
| 23 | Redundant hardware available                                                                                                                                                                                                                                                                                                                                                          | Redundant communications ports available                                                                                                        |
| 24 | Standard function available                                                                                                                                                                                                                                                                                                                                                           | Differential, CB fail, End zone                                                                                                                 |
| 25 | Optional functions available                                                                                                                                                                                                                                                                                                                                                          | Nils                                                                                                                                            |
| 26 | Reset through a single push button                                                                                                                                                                                                                                                                                                                                                    | Yes                                                                                                                                             |
| 27 | Future configuration and activation of new bays should be possible                                                                                                                                                                                                                                                                                                                    | Possible upto 28 bays                                                                                                                           |
| 28 | Filtering and evaluation of Analogue qty at bay level                                                                                                                                                                                                                                                                                                                                 | Yes                                                                                                                                             |
| 29 | Tripping to trip coil directly from Bay units                                                                                                                                                                                                                                                                                                                                         | Yes                                                                                                                                             |
| 30 | Connection and communication between Bay unit and Central unit                                                                                                                                                                                                                                                                                                                        | Through fiber optics                                                                                                                            |
| 31 | Blocking of zone in case of communication failure and annunciation thereof                                                                                                                                                                                                                                                                                                            | Yes                                                                                                                                             |
| 32 | Isolator integrity monitoring through software without any external relay and annunciation thereof                                                                                                                                                                                                                                                                                    | Yes                                                                                                                                             |
| 33 | DR / Event function in CU as well as BU with non volatile buffer memory                                                                                                                                                                                                                                                                                                               | Yes                                                                                                                                             |
| 34 | DR sampling freq. And total duration                                                                                                                                                                                                                                                                                                                                                  | 600 Hz and max 10.5 secs                                                                                                                        |
| 35 | Nos of events                                                                                                                                                                                                                                                                                                                                                                         | 512                                                                                                                                             |
| 36 | Availability of Blind zone detection & CB failure feature                                                                                                                                                                                                                                                                                                                             | Yes                                                                                                                                             |
| 37 | Differential current display of each zone                                                                                                                                                                                                                                                                                                                                             | Yes                                                                                                                                             |
| 38 | Continuous DC supervision                                                                                                                                                                                                                                                                                                                                                             | Through DC supervision relays                                                                                                                   |
| 39 | Central unit compatibility                                                                                                                                                                                                                                                                                                                                                            | 28 bays                                                                                                                                         |
| 40 | Availability of current reversal techniques for Bus Coupler bay                                                                                                                                                                                                                                                                                                                       | Yes                                                                                                                                             |

## 2. LOCAL BREAKER BACK-UP PROTECTION for ALL BAYS

| S.No. | Equipment                                                                                          | Specification                                                             |
|-------|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1     | Name and country of Manufacturer                                                                   | GE T&D India Limited                                                      |
| 2     | Manufacturer type and designation                                                                  | P442 (Numerical)                                                          |
| 3     | Setting Range                                                                                      |                                                                           |
|       | a) Current                                                                                         | Phase Under Current threshold for reset<br>$I_{<}: 0.05 - 3.2 \times I_n$ |
|       | b) Time                                                                                            | 0 – 10 Sec                                                                |
| 4     | Operating time                                                                                     | Less than 15 ms                                                           |
| 5     | Resetting time                                                                                     | Less than 15 ms                                                           |
| 6     | Operation indicator provided?                                                                      | Yes, in the form of LED's                                                 |
| 7     | Thermal rating                                                                                     | Continuous: 4 $I_n$ ,<br>for 10 s: 30 $I_n$ ,<br>for 1 s: 100 $I_n$       |
| 8     | Whether relay have re-trip feature for tripping its own CB after initiation with a set time delay? | Yes                                                                       |
| 9     | Communication                                                                                      | IEC 61850                                                                 |
| 10    | Disturbance recording                                                                              | Available. Configurable for specified inputs (8 analogue and 32 Digital)  |

### Annexure-1 to GTP

- 1) Energy Meter
- 2) CMRI

POWER LINE CARRIER TERMINAL FOR SPEECH & DATA TRANSMISSION

| Sr. No. | Technical parameters                                                                                                                                                     | System Particulars                                                                                              |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| 1       | Name of manufacturer & country                                                                                                                                           | APPSIL & India                                                                                                  |
| 2       | Type, model & Catalogue No.                                                                                                                                              | ETL600-050-1                                                                                                    |
| 3       | Type of modulation                                                                                                                                                       | Single Side Band with suppressed carrier & Single step frequency conversion with Direct Digital Synthesis (DDS) |
| 4       | Mode of transmission                                                                                                                                                     | Single Side Band with suppressed carrier                                                                        |
| 5       | Carrier frequency range                                                                                                                                                  | 40 to 500 kHz as per IEC 60495<br>Can be programmed for 24 to 1000 kHz                                          |
| 6       | Nominal carrier frequency band in either direction of transmission                                                                                                       | 4KHz                                                                                                            |
| 7       | Return loss within the nominal carrier frequency band                                                                                                                    | $\geq 10$ dB                                                                                                    |
| 8       | Effectively transmitted VF band                                                                                                                                          | 200-3400 Hz                                                                                                     |
| 9       | Return loss within the effectively transmitted voice frequency band                                                                                                      | $\geq 10$ dB                                                                                                    |
| 10      | HF oscillator details                                                                                                                                                    | Frequency Synthesizer Master Control Oscillator which derives all i.e. HF, AF.                                  |
| 11      | IF oscillator details                                                                                                                                                    | No IF conversion. Its Direct Digital Synthesis.                                                                 |
| 12      | Frequency difference between the VF input and VF output of a pair if terminals connected back to back for permissible ambient temperature and supply voltage variations. | 2 Hz                                                                                                            |
| 13      | Maximum HF amplifier output with single/multiple tone keying (peak envelope power).                                                                                      | 50 W The output power may be decreased via user interface program (HMI) in steps of 1 dB                        |
| 14      | Nominal carrier frequency power (peak envelop power) at output terminals.                                                                                                | 50 W                                                                                                            |
| 15      | HF impedance at output of carrier terminals.                                                                                                                             | 75 ohms.                                                                                                        |

|                             |                                        |                      |                       |                  |
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|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 16 | Stability of the carrier frequency                                                                                                                                              | $\leq \pm 1$ Hz                                                                                                                         |
| 17 | Improvement S/N due to compander                                                                                                                                                | 10 dB                                                                                                                                   |
| 18 | Whether carrier is suppressed or reduced during transmission of signal                                                                                                          | Suppressed                                                                                                                              |
| 19 | Whether frequency locking between Tx/Rx provided.                                                                                                                               | Yes                                                                                                                                     |
| 20 | Automatic gain control range and regulation                                                                                                                                     | 40 dB dynamic range                                                                                                                     |
| 21 | Level of spurious emission at (a) Edge of nominal carrier frequency band. (b) 4KHz away from nominal carrier frequency band. (c) 8KHz away from nominal carrier frequency band. | As per IEC 62488-2,2017 clause no. 5.8                                                                                                  |
| 22 | Relative level at VF 4 wire terminating points.<br>(a) Send leg<br>(b) Receive leg                                                                                              | (a) -20 to +5 dBm programmable in steps of 0.25 dB-3.5 dB default<br>(b) -20 to +10 dBm programmable in steps of 0.25 dB-3.5 dB default |
| 23 | Permissible limits for level variation with frequency relative to 800 Hz in a speech channel (without companders) transmitted over a pair of terminals connected back to back   | As per IEC 60495                                                                                                                        |
| 24 | Level of telephone signaling channel(a) input level b) Output level                                                                                                             | (a) Potential free contact, $\leq 500$ Ohm.<br>(b) Potential free contact rating 50mA/72V                                               |
| 25 | Near and far end cross talk due to telephone signaling channel in a pair of PLC terminals (without companders) connected back to back.                                          | $\leq -50$ dBm0p                                                                                                                        |
| 26 | Pulse distortion of telephone signaling when operated at signaling speed of 10 pps and with a mark to space ratio of                                                            | $\leq 2$ msec.                                                                                                                          |

|                             |                                        |                      |                       |                  |
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|    |                                                                                                                                                                                          |                                                         |
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|    | 40/60 in PLC terminals connected back to back.                                                                                                                                           |                                                         |
| 27 | Psophometric noise contribution of a pair of PLC terminals connected back to back.                                                                                                       | $\leq -50$ dBm0p                                        |
| 28 | Group delay distortion in the frequency band relevant to the transmission of protection signals.                                                                                         | As per IEC 62488-2,2017 clause no.6.7                   |
| 29 | Performance under noise condition. a. Noise generated within terminal. b. Additional noise introduced when terminals are connected back to back at repeater station. c. Noise bandwidth. | (a) $\leq -55$ dBm0p<br>(b) Negligible<br><br>(c) 4 kHz |
| 30 | Power supply requirements. a. Voltage. b. permissible voltage variation. c Maximum current. d. Quiescent current                                                                         | (a) -48V DC<br>(b) +20%, -15%<br>(c) 5.8A<br>(d) 2.8A   |
| 31 | Installation details                                                                                                                                                                     | Housed in floor mounting steel cabinet                  |
| 32 | Insulation level                                                                                                                                                                         | 1KV                                                     |
| 33 | Meter provided on test panel, their range and purpose.                                                                                                                                   | HMI Software Provided for Maintenance & Testing         |
| 34 | Is the equipment suitable to work in dust laden atmosphere?                                                                                                                              | Yes, but not advisable.                                 |
| 35 | Whether interior lamps with door switch is provided in cabinet?                                                                                                                          | Yes, but with a separate switch to operate them.        |
| 36 | Overall dimensions(cabinet) a. Length mm. b. Width mm. c. Height mm                                                                                                                      | 1800(H) X 730(W) X 530(D)                               |
| 37 | Weight                                                                                                                                                                                   | 160 kg approx                                           |
| 38 | Earthing detail of PLC cabinet                                                                                                                                                           | Copper earth bar is provided inside cabinet             |
| 39 | Whether Tx/Rx loop-back facility is available for testing locally                                                                                                                        | Yes (Using HMI600 software)                             |
| 40 | Whether site tuneable ?                                                                                                                                                                  | Yes (Using HMI600 software)                             |

|                             |                                        |                      |                       |                  |
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