

# POWER GRID BANGLADESH PLC



## Bidding Document for

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS  
Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO  
Lines on turnkey basis (package-1)**

### Volume 3A of 3 [Substation]

Issued on :  
Invitation for Bids No. : 27.21.0000.101.07.425.24.6193  
Contract No. : POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender  
Country : Bangladesh  
Employer:



### Power Grid Bangladesh PLC

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# POWER GRID BANGLADESH PLC

## BIDDING DOCUMENT

### FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]**

## SCHEDULE A

### INTRODUCTION & PREAMBLE TO THE PRICE & TECHNICAL SCHEDULES

#### BRIEF DESCRIPTION OF THE WORKS

The bidder shall be deemed to have visited site, inspected, gathered data and verified details of the as-built system in order to design, supply and interface their new equipment. All necessary materials, adjustments, dismantling, remedial and tidying-up work in order to complete the work specified shall be included in the contract price. **The contractor is responsible for ensuring that all and/or any item(s) of work required for the safe, efficient and satisfactory completion and functioning of the works, are included in the Bid Price whether they be described in the specification or not.**

The scope of works under this turnkey contract is: design, supply, manufacture, quality assurance, inspection and testing, delivery, new packing for export, insurance, shipment & transport to the site, complete construction and installation, jointing, terminating, bonding, earthing, painting, setting to work, site testing and commissioning, defect liability for all equipment, including all civil works of new 400/230/132KV AIS substations.

All necessary works have to including in the contract price, including all kinds of dismantling works, if any.

The civil design has to incorporate counter measures against flooding so as not to affect any substation equipment during the wet season. Given the recorded past maximum flood water level in the project area, sufficient ground level height for land formation is required at the Contractor's responsibility.

The Bidders are advised to conduct site visits, to inform themselves and to carry out their own assessment on all concern sites according to their needs before the submission of their bids. The Employer may arrange necessary permission, if required by the Bidders.

The geotechnical studies and soil investigations are in the Contractor's scope of work.

The Civil Design and backfilling have to consider and incorporate protection measures against flooding. The sufficient ground level height for land formation is required at the Contractor's responsibility and will be subject of the Employer's approval. Finishing Ground Level (FGL) shall be at least 500 mm above the Highest Flooding Level (HFL). The Bidders has to inform themselves about the HFL.

Generally, land development of new substation shall be made for the total substation area and perimeter wall shall be made for the total substation area.

The Contractor's responsibility is to provide that all parts of the works be completed in every respect for commercial operation, to the requirements of the Engineer.

All details, accessories etc. required for the complete installation and satisfactory operation of the works not specifically mentioned in this specification are deemed included in the contract price.

In case of extension and renovation works, not all required as-built drawings may be available for the existing plant and equipment, which required modification/renovation; the Contractor is also responsible to make drawings as required to complete the works.

The drawings provided in the bidding documents are indicative only and hence do not reflect the entire scope of works. The Bidder has to consider all Tender drawings as preliminary and for Tender purpose only. The drawings may be changed at the time of execution. All dimensions are preliminary and general. Not all equipment is shown on the drawings. Details are not shown at all. The Contractor has to make Engineering and to provide detail calculation, detail design and detail drawings of the complete facilities, which will be subject of the Employer's approval.

The Bidder is be deemed to have visited site, inspected, gathered data and verified details of the as-built system in order to design, supply and interface their new equipment. All necessary materials, adjustments, dismantling, remedial and tiding-up work in order to complete the work specified shall be included in the contract price

The other ends of Transmission Lines have to be covered from the tele-communication point of view under the scope of this contract. All equipment and services have to be provided

All necessary materials, adjustments, dismantling, remedial and tiding-up work in order to complete the work specified shall be included in the contract price.

The bid price shall include supply and delivery of mandatory spare parts.

The bid price shall include all other miscellaneous works required.

The programme of works shall be as shown in Schedule C - Times for Delivery and Completion. Within one month of acceptance of the bid, the Contractor shall submit a programme chart detailing times required for the design, supply, delivery, installation, testing and commissioning for the complete work.

The "Schedule of Requirements" for equipment, materials and services and the guaranteed technical particulars of equipment and materials will be stated in Schedule A of this bidding

document shall be read in conjunction with the detailed technical specifications of equipment and materials described in Volume 2 of the bidding documents.

The "Price Schedule" for equipment, materials and services will be stated in Schedule B of this bidding document shall be read in conjunction with the detailed technical specifications of equipment and materials described in Volume 2 of the bidding documents

The scope of work comprises the following: -

### **DESCRIPTION OF WORKS**

#### **1. PEKUA 400/230/132kV AIS Substation**

The scope of work under this turnkey Bid is design, supply, delivery, installation, testing & commissioning of a new Air Insulated Switchgear (AIS) substation. The configuration of the 400kV busbar shall be 1 and ½ busbar scheme and the 230KV & 132kV busbar shall be double Busbar scheme.

The scope of work also includes associated control, protection, fiber optic multiplexer equipment for communication & protection, substation automation, digital fault & disturbance recorder (DFDR), station power facilities, including towers and gantry structures, a new three storied Main Control Room Building, two(2) nos one storied switchyard panel room in 400kV switchyard and one nos one storied switchyard panel room in 132kV switchyard to accommodate protection and control IED and associated equipment, local control kiosks, 33kV tertiary equipment, cable trenches, water supply & sewerage, fences, access road & internal roads, security guard stations, and all other necessary substation facilities and supply of mandatory spare parts and maintenance & special tools.

#### **400kV Air Insulated Switchgears (AIS)**

New 400kV AIS switchyard for Four(4) 400kV line bays to connect Line in-out of existing 400kV Matarabari-Bashkhali 400kV double circuit overhead line (Matarabari 1 & 2 and Bashkhali 1 & 2); Three 400kV transformer bays for three sets of 400/230/33kV, 400/520MVA, three phase auto transformers; space shall be kept for future extension of four (4) 400kV overhead line bays.

#### **230kV Air Insulated Switchgears (AIS)**

New Two 230kV line bays to connect Line in-out of existing 230kV Anwara-Cox's Bazar 230kV double circuit overhead line (Anwara 1 & 2); —Three 230kV transformer bays for LV side of three 400/230/33kV transformer; Two 230kV transformer bays for HV side of two 230/132/33kV transformer; one 230kV bus-coupler bay; space shall be kept for future extension of four (4) 230kV overhead line bays and one 230kV transformer bays for HV side of 230/132/33kV, 225/300MVA transformer.

### **132kV Air Insulated Switchgears (AIS)**

New 132kV AIS switchyard for Four 132kV line bays to connect Line in-out of existing 132kV Matarbari-Chokoria 230kV double circuit overhead line (Matarbari 1 & 2 and Chokoria 1 & 2); • Two 132kV line bays to connect with coxbazar 132/33KV Grid substation (Cox's Bazar 1 & 2); Two 132kV transformer bays for LV side of two 230/132/33kV transformer; one 132kV bus-coupler bay; space for future extension of four overhead 132kV line bays and one 132kV transformer bays for LV side of 230/132/33kV transformer.

### **33kV Air Insulated Switches and Connection**

New 33kV AIS switchyard and switches for station power service facilities;

- 400/230/33kV tertiary side switchyard and connection
- 230/132/33kV tertiary side switchyard and connection

Tertiary side connection between 33kV terminal to switches including necessary fittings, structures and conductors and XLPE for 400/230/33kV transformer bank.

Tertiary side connection between 33kV terminal to switches including necessary fittings, structures conductors for 230/132/33 transformer bank.

### **400/230/33kV three phase 3 phase transformer**

Three 400/230/33kV, 400/520MVA three phase auto transformers.

### **230/132/33kV three phase 3 phase transformer**

Two 230/132/33kV, 225/300MVA three phase auto transformers, and space for future extension of one 230/132/33kV, 225/300MVA three phase auto transformer.

### **33/0.415kV earthing/auxiliary transformer**

Two 33/0.415kV, 500kVA, outdoor type earthing/auxiliary transformers to supply the substation auxiliary loads. The auxiliary transformer shall be connected to tertiary side of two new 400/230/33kV three phase transformers.

### **Control, Protection, Substation Automation, Metering & DFDR**

Associated local & Remote control panel, metering panel, protection equipment, synchronizing scheme and substation automation system (SAS) & DFDR for complete substation. Monitoring of status of Bus PT & Bus ES need to be included in the SAS. Necessary works to be performed so that Air temperature in the SPRs

can be controlled and monitored through SAS. RTCC, LVAC, LVDC, Tariff metering panel & other panel shall be monitored by SAS.

### **Fibre Optic Multiplexer Equipment for Communication and Protection**

Indoor type Fibre Optic Multiplexer Equipment for protection & communication.

### **DC and LVAC System**

Complete set of DC and LVAC system with all necessary materials required for the plant being installed with spares for future use of 110V DC battery & battery charger, 48 V DC battery & battery charger, DC distribution board and LVAC distribution board.

### **Civil Works, Building and Foundation**

Land development of complete switchyard area by cutting, land filling, compacting up to a suitable level including slope protection.

Complete design, supply and construction of all civil items required for the outdoor works suitable for switchyard gantry & equipment foundations, transformer foundations, blast walls, oil pit; approach, entrance & internal roads; cable trenches, septic tank, surfacing, drainage, fences, guard house including earthing & lightning protection, switchyard lighting, etc.

Complete design, supply and construction of all civil items including all necessary architecture & structural requirements; cable trays, fittings and flooring & finishes; air-conditioning and lighting for a new three storied Main Control Room Building, two(2) nos one storied switchyard panel room in 400kV switchyard and one nos one storied switchyard panel room in 132kV switchyard

Complete design, supply and construction of fire-fighting system for transformers including water pipe network and reservoir at normal pressure.

### **SCADA system for Telecontrol and Telemetry**

Complete design, supply, delivery, installation, testing & commissioning of hardware and software to provide the telecontrol &telemetry facilities required at the existing National Load Dispatch Center(NLDC) at Rampura for integration of complete new 400/230/132kV substation. All required electrical signals shall be transmitted to the NLDC through the Industrial Gateway of the substation automation system. All HV breakers, motorized disconnectors, tap changer, etc. shall be controlled form NLDC through the Gateway of the substation automation system using IEC 60870-5-101 protocol. All necessary modification works in the software of master station of NLDC are to be carried out.

**Mandatory Spare parts including Maintenance Equipment**

Supply of complete mandatory spare and spare parts of transformer, switchgear, control equipment, protection relays, meters, erection & test equipment. Printed catalogue, operation and service manual are to be provided. The materials shall have to be handed over to the designated store as per instruction of the Engineer.

**2. O & M training for new substations:**

The Contract Price shall include all costs of training and the instruction of staff on site for the following:

**Local Training:** On-site instruction by the manufacturer's engineer on operations and maintenance of the (i) HV switchgears & transformers (ii) protection & Substation automation system (iii) fiber optic multiplexer. Each program shall be arranged for a period of two(2) weeks and for fifteen(15) PGCB engineers.

For on-site instruction training, the contractor shall not be responsible for any costs for trainees except meal and the aforementioned onsite trainings shall have to be arranged at any Substation's respective local Grid Circle or GMD area with the consultation of Superintending Engineer, Grid Circle, PGCB. In "Schedule B4.2: Installation and Other Services" of the Price Schedule, cost of Local O&M Training are given as provisional sum. These costs are fixed ceiling and will be included in total price. But the payment shall be at actual upon submission of relevant document.

For Transformer & HV substation training, the trainer shall be experience of at least 400kV Class, 520MVA Substation & transformer design experience for at least 5 years. For other training, the trainer shall be experience of related field experience for at least 5 years. The CV of proposed trainers shall be submitted to employer & taken approval during execution. If the proposed trainer does not meet the minimum requirements mentioned here, the Employer shall preserve the right to ask the contractor to change the trainer as per requirement. All the trainers shall be certified by OEM.

The Contractor shall have to submit the Schedule of each Training and taken approval from the Employer prior 3 months before conducting each Training.

**3. Factory acceptance tests:**

The Contract Price shall include all costs of factory acceptance tests at manufacturers' works and the instruction of staff on site for the following:

| SL | Description                  |
|----|------------------------------|
| 1. | Transformers                 |
| 2. | Circuit Breaker              |
| 3. | Disconnecter                 |
| 4. | Instrument Transformer ( PT) |
| 5. | Instrument Transformer ( CT) |
| 6. | Lightning Arrester           |
| 7. | Control, protection & SAS    |
| 8. | DC system                    |

The Contractor shall have to submit the Schedule and factory acceptance test format of each stated above and taken approval from the Employer prior 3 months before conducting each factory acceptance test. factory acceptance test shall be inspected by contractor's representative.

## SCHEDULE A

### REQUIREMENTS

#### **Section-I**      **PEKUA 400/230/132kV AIS Substation**

The equipment to be designed, supplied, installed, tested & commissioned as stipulated in bid specification and shown in bid drawings (volume 2 of 3):

|             |                    |
|-------------|--------------------|
| <b>Item</b> | <b>Description</b> |
|-------------|--------------------|

|           |                                              |
|-----------|----------------------------------------------|
| <b>1A</b> | <b>420 kV Air Insulated Switchgear (AIS)</b> |
|-----------|----------------------------------------------|

The 420kV AIS shall comply with the particular requirements as detailed in the Schedule of Technical Requirements included as Appendix A1 to this section and shall comprise the following:-

- |       |                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1A1   | 420KV Circuit breaker associated with transformer switching                                                                                                                                                                                                                                                                                                                          |
| 1A1.1 | Four(4) sets of 420kV, <b>4000A</b> , 63kA/1sec, 50Hz, 1425kVp BIL, live tank type, gang operated, SF6 gas circuit breakers with spring-stored energy operating mechanism. CSD ( <b>Control Switching Device</b> ) is required for transformer switching which shall have to be considered for 400kV circuit breaker.                                                                |
| 1A1.2 | One(1) sets of 420kV, <b>4000A</b> , 63kA/1sec, 50Hz, 1425kVp BIL, live tank type, <b>single-pole operated</b> , SF6 gas circuit breakers with spring-stored energy operating mechanism. PIR ( <b>Pre insertion resistor</b> ) and CSD ( <b>Control Switching Device</b> ) is required for line & transformer switching which shall have to be considered for 400kV circuit breaker. |
| 1A2   | Eight (8) sets of 420kV, <b>4000A</b> , 63kA/1sec, 50Hz, 1425kVp BIL, live tank type, <b>single-pole operated</b> , SF6 gas circuit breakers with spring-stored energy operating mechanism. PIR ( <b>Pre insertion resistor</b> )is required for line switching which shall have to be considered for 400kV circuit breaker.                                                         |
| 1A3   | Four(4) sets of 420kV, <b>4000A</b> , 63kA/1sec , 50Hz, 1425kVp BIL, horizontal double break, post type, motor operated disconnectors <b>with</b> motor-operated <b>earthing switch</b> .                                                                                                                                                                                            |
| 1A4   | Twenty Nine (29) sets of 420kV, <b>4000A</b> , 63kA/1sec , 50Hz, 1425kVp BIL, horizontal double break, post type, motor operated disconnectors <b>without earthing switch</b> .                                                                                                                                                                                                      |
| 1A5   | Two(2) sets of 420kV, 63kA/1sec , 50Hz, 1425kVp BIL, post type, motor operated busbar grounding switches.                                                                                                                                                                                                                                                                            |

- 1A6      Seventy eight (78) nos. of single-phase, 6-core, 420kV, **4000A**, 63kA/1sec , 50Hz, 1425kVp BIL,post type current transformer. **400kV, 63kA/1s single phase, 6-core, current transformer with cores as follows:**  
Bus side CT  
 4000-2000/1A, Class 5P20, 30-60VA for Main 1 Protection  
 4000-2000/1A, Class 5P20, 30-60VA for Main 2 Protection,  
 4000-2000/1A, Class 0.2S,15VA(min burden) for Metering 1  
 4000-2000/1A, Class 5P20, 30-60VA  
 4000-2000/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure  
 4000-2000/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure  
Mid breaker CT  
 4000-2000/1A, Class 5P20, 30-60VA for Main 1 Protection  
 4000-2000/1A, Class 5P20, 30-60VA for Main 2 Protection,  
 4000-2000/1A, Class 0.2S,15VA(min burden) for Metering 1  
 4000-2000/1A, Class 5P20, 30-60VA  
 4000-2000/1A, Class 5P20, 30-60VA  
 4000-2000/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure  
 [Actual Burden shall be finalized at execution time based on sizing calculation.  
 Accuracy & VA shall have to be defined for all ratio]
- 1A7      Twenty seven (27) nos. of single-phase, 3-core,  **$420/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  kV/V/V/V, 5P20/5P20/0.2, 20-50/20-50/10-20VA** 420kV, 63kA/1sec, 50Hz, 1425kVp BIL,capacitor type voltage transformers.  
 [Actual Burden shall be finalized at execution time based on sizing calculation.  
 Accuracy & VA shall have to be defined for all ratio]
- 1A8      Twenty seven (27) nos. of 390kV rated voltage, 303kV(rms) continuous operating voltage at 50°C, 10kA nominal discharge current, 50Hz, Heavy duty station class, gapless metal oxide type, single phase surge arresters.
- 1A9      Four (4) nos. of wave trap (single phase, 420kV, **4000A**, 1mH).
- 1A10      One (1) lot of 400kV post type support insulators required for completing 420kV busbar and switchgear as specified in the technical specifications and bid drawings.
- 1A11      One(1) lot of rigid tubular bus [Aluminium of grade 63401 WP],flexible conductors, insulators, fittings including all necessary clamps and connectors required for completing 420kV busbar and switchgear connection as specified in the technical specifications and bid drawings.
- 1A12      One(1) lot of steel structures for gantry and equipment supports required for completing 420kV busbar and switchgear as specified in the technical specifications and bid drawings.

## **1B 245kV Air Insulated Switchgear (AIS)**

The 245kV AIS shall comply with the particular requirements as detailed in the Schedule of Technical Requirements included as Appendix A1 to this section and shall comprise the following:-

- 1B1 Five (5) sets of 245kV, 2000A, 50kA/1sec, 50Hz, 1050kVp BIL, live tank type, gang operated, SF6 gas circuit breakers with spring-stored energy operating mechanism (for Transformer bay).
- 1B2 two(2) sets of 245kV, 2000A, 50kA/1sec, 50Hz, 1050kVp BIL, live tank type, single-pole operation, SF6 gas circuit breakers with spring-stored energy operating mechanism (for T/L bay).
- 1B3 One (1) set of 245kV, 3150A , 50kA/1sec, 50Hz, 1050kVp BIL, live tank type, gang operated, SF6 gas circuit breakers with spring-stored energy operating mechanism (for bus coupler).
- 1B4 Fifteen (15) sets of 245kV, 2000A, 50kA/1sec, 50Hz, 1050kVp BIL, double side break, post type, motor operated disconnectors without earthing switch (for Transformer bay).
- 1B5 Four(4) sets of 245kV, 2000A, 50kA/1sec 50Hz, 1050kVp BIL, double side break, post type, motor operated disconnectors without earthing switch (for T/L bay).
- 1B6 Two (2) sets of 245kV, 3150A , 50kA/1sec, 50Hz, 1050kVp BIL, double side break, post type, motor operated disconnectors without earthing switch (for bus coupler).
- 1B7 Two(2) sets of 245kV, 2000A, 50kA/1sec, 50Hz, 1050kVp BIL, double side break, post type, motor operated disconnectors with motor-operated earthing switch (for T/L bay).
- 1B8 Fifteen (15) nos. of single-phase, 5-core, 245kV, 50kA/1s, 50Hz, 1050kVp BIL , post type current transformer for Transformer bay: **245kV, 50kA/1s single phase, 6-core, current transformer with cores as follows:**  
**2400-1600-800/1A, Class 5P20, 30-60VA for Main 1 Protection**  
**2400-1600-800/1A, Class 5P20, 30-60VA for Main 2 Protection,**  
**2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 1**  
**2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 2, BCU**  
**2400-1600-800/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure**  
**2400-1600-800/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure**

[Actual Burden shall be finalized at execution time based on sizing calculation.  
Accuracy & VA shall have to be defined for all ratio]

- 1B9 Six(6) nos. of single-phase, 5-core, 245kV, 50kA/1sec, 50Hz, 1050kVp BIL , post type current transformer for Line bay **245kV, 50kA/1s single phase, 6-core, current transformer with cores as follows:**

**2400-1600-800/1A, Class 5P20, 30-60VA for Main 1 Protection**  
**2400-1600-800/1A, Class 5P20, 30-60VA for Main 2 Protection,**  
**2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 1**  
**2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 2, BCU**  
**2400-1600-800/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure**  
**2400-1600-800/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure**  
**[Actual Burden shall be finalized at execution time based on sizing calculation.**  
**Accuracy & VA shall have to be defined for all ratio]**

- 1B10 Three(3) nos. of single-phase, 4-core, 245kV, 50kA/1sec, 50Hz, 1050kVp BIL , post type current transformer for bus coupler bay: **245kV,50kA/1s, single phase, 4-core, current transformer with cores as follows:**

- **3000-1500/1A, class 0.2S, 15VA(min burden) for measuring, BCU**
- **3000-1500/1A, class PX, 30-60VA for Busbar Differential Protection**
- **3000-1500/1A, class PX, 30-60VA for Busbar Differential Protection**
- **3000-1500/1A, class 5P20, 30-60VA for Protection**

**[Actual Burden shall be finalized at execution time based on sizing calculation.**  
**Accuracy & VA shall have to be defined for all ratio]**

- 1B11 Twenty seven (27) nos. of single-phase, 3-core,  **$230/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  kV/V/V/V,** **5P20/5P20/0.2, 20-50/20-50/10-20VA** 245kV, 50kA/1sec, 50Hz, 1050kVp BIL, capacitor type voltage transformers.

**[Actual Burden shall be finalized at execution time based on sizing calculation.**  
**Accuracy & VA shall have to be defined for all ratio]**

- 1B12 Twenty one (21) nos. of 198kV rated voltage, 160kV(rms) continuous operating voltage at 50°C, 10kA nominal discharge current, 50Hz, Heavy duty station class, gapless metal oxide type, single phase surge arresters.

- 1B13 One(1) lot of flexible conductors for bus and jumper, insulators, fittings including all necessary clamps and connectors required for completing 245kV busbar and switchgear connection as specified in the technical specifications and bid drawings.

1B14 One(1) lot of steel structures for gantry and equipment supports required for completing 245kV busbar and switchgear as specified in the technical specifications and bid drawings.

**Deleted**

**1C 145kV Air Insulated Switchgear (AIS)**

The 145kV AIS shall comply with the particular requirements as detailed in the Schedule of Technical Requirements included as Appendix A1 to this section and shall comprise the following:-

1C1 Two (2) sets of 145kV, 1600A, 40kA/1sec, 50Hz, 650kVp BIL, live tank type, gang operated, SF6 gas circuit breakers with spring-stored energy operating mechanism (for Transformer bay).

1C2 Six(6) sets of 145kV, 1600A, 40kA/1sec, 50Hz, 650kVp BIL, live tank type, single-pole operation, SF6 gas circuit breakers with spring-stored energy operating mechanism (for T/L bay).

1C3 One (1) set of 145kV, 3150A, 40kA/1sec, 50Hz, 650kVp BIL, live tank type, gang operated, SF6 gas circuit breakers with spring-stored energy operating mechanism (for bus coupler).

1C4 Six(6) sets of 145kV, 1600A, 40kA/1sec, 50Hz, 650kVp BIL,double side break, post type, motor operated disconnectors without earthing switch (for Transformer bay).

1C5 Twelve(12) sets of 145kV, 1600A, 40kA/1sec, 50Hz, 650kVp BIL, double side break, post type, motor operated disconnectors without earthing switch (for T/L bay).

1C6 Two (2) sets of 145kV, 3150A, 40kA/1sec, 50Hz, 650kVp BIL,double side break, post type, motor operated disconnectors without earthing switch (for bus coupler).

1C7 Six(6) sets of 145kV, 1600A, 40kA/1sec, 50Hz, 650kVp BIL, double side break, post type, motor operated disconnectors with motor-operated earthing switch (for T/L bay).

1C8 Six(06) nos. of single-phase, 5-core, 145kV, 40kA/1sec, 50Hz, 650kVp BIL, post type current transformer for Transformer bay **145kV, 40kA/1sec single phase, 5-core, current transformer with cores as follows:**

**2400-1600-800/1A, Class 5P20, 30-60VA for Main 1 Protection**

**2400-1600-800/1A, Class 5P20, 30-60VA for Main 2 Protection,**

2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 1  
 2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 2, BCU  
 2400-1600-800/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure  
 [Actual Burden shall be finalized at execution time based on sizing calculation.  
 Accuracy & VA shall have to be defined for all ratio]

1C9 Eighteen(18) nos. of single-phase, , 5-core, 145kV, 40kA/1sec, 50Hz, 650kVp BIL , post type current transformer for Line bay **145kV, 40kA/1sec single phase, 5-core, current transformer with cores as follows:**  
 2400-1600-800/1A, Class 5P20, 30-60VA for Main 1 Protection  
 2400-1600-800/1A, Class 5P20, 30-60VA for Main 2 Protection,  
 2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 1  
 2400-1600-800/1A, Class 0.2S,15VA(min burden) for Metering 2, BCU  
 2400-1600-800/1A, PX, 30VA for Busbar Differential Protection and Breaker Failure  
 [Actual Burden shall be finalized at execution time based on sizing calculation.  
 Accuracy & VA shall have to be defined for all ratio]

1C10 Three(3) nos. of single-phase,145kV, 40kA/1sec, 50Hz, 650kVp BIL, post type current transformer for bus coupler bay. **145kV, 40kA/1sec single phase, 4 -core, current transformer with cores as follows:**  
 - 3000-1500/1A, class 0.2S, 15VA(min burden) for measuring, BCU  
 - 3000-1500/1A, class PX, 30-60VA for Busbar Differential Protection  
 - 3000-1500/1A, class PX, 30-60VA for Busbar Differential Protection  
 - 3000-1500/1A, class 5P20, 30-60VA for Protection

[Actual Burden shall be finalized at execution time based on sizing calculation.  
 Accuracy & VA shall have to be defined for all ratio]

1C11 Thirty (30) nos. of single-phase, 3-core,  **$132/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  kV/V/V/V**, **5P20/5P20/0.2, 20-50/20-50/10-20VA** 145kV, 40kA/1sec, 50Hz, 650kVp BIL,inductive type voltage transformers.  
 [Actual Burden shall be finalized at execution time based on sizing calculation.  
 Accuracy & VA shall have to be defined for all ratio]

1C12 Twenty Four(24) nos. of 120kV rated voltage, 102kV(rms) continuous operating voltage at 50°C, 10kA nominal discharge current, 50Hz, Heavy duty station class, gapless metal oxide type, single phase surge arresters.

1C13 One(1) lot of flexible conductors for bus and jumper, insulators, fittings including all necessary clamps and connectors required for completing 145kV busbar and switchgear connection as specified in the technical specifications and bid drawings.

1C14 One(1) lot of steel structures for gantry and equipment supports required for completing 145kV busbar and switchgear as specified in the technical specifications and bid drawings.

### 1D 36kV Air Insulated Switches and Connection for Auxiliary Transformers

The 36kV AIS shall comply with the particular requirements as detailed in the Schedule of Technical Requirements included as Appendix A1 to this section and shall comprise the following:-

1D1 Two(2) sets of 36kV, 800A, 31.5 kA/1sec, 50Hz, 170kVp BIL, vacuum circuit breakers with spring-stored energy operating mechanism.

1D2 Four(4) sets of 36kV, 800A, 31.5 kA/1sec, 50Hz, 170kVp BIL, single vertical break, post type, motor operated disconnectors.

1D3 Fifteen(15) nos. of single-phase, 2-core,  $33/\sqrt{3}$  /  $110/\sqrt{3}$  /  $110/\sqrt{3}$  kV/V/V, 5P20/0.2, 20-50/10-20VA 36kV, 31.5kA/1sec, 50Hz, 170kVp BIL, inductive type voltage transformers.  
[Actual Burden shall be finalized at execution time based on sizing calculation. Accuracy & VA shall have to be defined for all ratio]

1D4 Fifteen(15) nos. of 30kV rated voltage, 10kA nominal discharge current, 50Hz, Heavy duty station class, single phase surge arresters.

1D5 One(1) lot of Tertiary side connection between 36kV terminal to switches including necessary fittings, structures and conductors and XLPE for 400/230/33kV transformer.

1D6 Three(3) sets of 36kV, 31.5 kA/1sec, 50Hz, 170kVp BIL, post type current transformer.  
-100/1A, Class 0.2S, 10VA(min burden) for Metering 1 & Metering 2  
-800/1, class 5P20, 30VA for protection  
-800/1, class 5P20, 30VA for protection  
-800/1, class 5P20, 30VA for protection

**1E Power Transformers & Earthing/Auxiliary Transformers**

- 1E1 Three(3)sets of 400/230/33kV, 400/520MVA (ONAN/ONAF), three phase outdoor type power transformers, equipped with 33 kV tertiary winding (brought out to terminal bushings).
- 1E2 Two (2)sets of 230/132/33 kV, 225/300 MVA (ONAN/ONAF), three phase outdoor type power transformers, equipped with 33 kV tertiary winding (brought out to terminal bushings).
- 1E3 Two(2) sets 33/0.415 kV, 500kVA three phase outdoor type earthing/auxiliary Zig-Zag transformers associated Bushing & outdoor neutral CTs and steel support structures including all necessary connections. The delta connected tertiary windings of two new 400/132/33kV3 phase transformers shall supply the two 33/0.415 kV, auxiliary Zig-Zag transformer for the purpose of supplying the substation auxiliary power requirements.
- 1E4 One(1) sets Complete water spray fire fighting system for all 400/230/33 kV three phase outdoor type power transformer
- 1E5 One(1) sets Complete water spray fire fighting system for all 230/132/33 kV three phase outdoor type power transformer
- 1E6 Three (03) sets of On-line Dissolved Gas & moisture monitoring system for 400/230/33kV auto transformers bank

**1F Control, Protection, Monitoring, Substation Automation & Metering**

The equipment to be supplied, installed and commissioned is shown in bid drawings are comprising of:-

- 1F1 One(1) lot of Complete station SAS panels including all required equipment & accessories for the whole Substation. SAS system shall include BCU for 400kV, 230kV, 132 kV level and auxiliaries.: as per Protection SLD, Two (02) sets of Industrial Server PC ( latest generation) cum Operator workstation (Main & Redundant) with SAS & Engineering Software, Firewall, 55" or Large LED Monitor, One(01) lot of Ethernet Switch, One (01) set of GPS system, Two (02) sets of Printer, A4 Laser (One black & White, Other Color), One (01) nos of Engineering PC: (core i7-latest generation, 1TB (RAID 1) SSD, 16GB RAM, 27" display for SAS & SCADA), panels, Cables (Fiber Optic, Ethernet, Copper etc.), One (01) set of Common alarm unit with hooter/buzzer for annunciation etc & other accessories. Any other accessories shall be provided to complete the whole SCADA system as required.

**400 kV Circuits**

The equipment to be supplied, installed and commissioned is shown in bid drawings are comprising of:-

- 1F2 Control, Protection & Monitoring and Substation Automation System including event recording function for Four (4) sets of overhead line circuit bays. The control panels shall be supplied considering complete diameter..
- 1F3 Control, Protection & Monitoring and Substation Automation System including event recording function for three(3) sets of 400/230/33kV three phase, auto power transformer circuits including transformer tap changer control, fan control & AVR as per 4.15(N) of section 4 in volume 2 of 3. The control panels shall be supplied considering complete diameter.
- 1F4 Two (2 ) set of Busbar protection for 400kV system
- 1F5 One (1) set of Independent standalone Digital Fault and Disturbance recorder (DFDR) with travelling wave fault locator to monitor all bays.
- 1F6 One (1) lot of Tariff metering panel to accommodate programmable & recordable digital 3-phase, 4-wire import and export MWh and MVARh meters (accuracy class 0.2) for each 400kV line and transformer feeder. For each feeder minimum two meters (main & check) including one set software and communication cord. Substation Automation System shall include the metering for all the bays. Tariff Metering is to be supplied from Europe, Canada, USA or Japan origin. Printed catalogue, operation and service manual are to be provided.

### **245kV Circuits**

The equipment to be supplied, installed and commissioned is shown in bid drawings are comprising of :-

- 1F7 Control, Protection & Monitoring and Substation Automation System including event recording function for two(2) sets of overhead line circuits bays.
- 1F8 Control, Protection & Monitoring and Substation Automation System including event recording function for two(2) sets of 400/230/33 kV power transformer circuits including transformer tap changer control.
- Control, Protection & Monitoring and Substation Automation System including event recording function for three(3) sets of 230/132/33kV three phase, auto power transformer circuits including transformer tap changer control, fan control & AVR as per 4.15(N) of section 4 in volume 2 of 3.
- 1F9 Control, Protection & Monitoring and Substation Automation System including event recording function for one(1) set of bus coupler circuit.

- 1F10 Two (2 ) sets of Busbar protection for 230kV system
- 1F11 One (1) set of Independent standalone Digital Fault and Disturbance recorder (DFDR) to monitor all bays.
- 1F12 One (1) lot of Tariff metering panel to accommodate programmable & recordable digital 3-phase, 4-wire import and export MWh and MVARhmeters (accuracy class 0.2) for each 132 kV line and transformer feeder. For each feeder minimum two meters (main & check) including one set software and communication cord. Substation Automation System shall include the metering for all the bays. Tariff Metering is to be supplied from Europe, Canada, USA or Japan origin. Printed catalogue, operation and service manual are to be provided.

### 145 kV Circuits

The equipment to be supplied, installed and commissioned is shown in bid drawings are comprising of :-

- 1F13 Control, Protection & Monitoring and Substation Automation System including event recording function for Six (6) sets of overhead line circuits bays.
- 1F14 Control, Protection & Monitoring and Substation Automation System including event recording function for two(2) sets of 230/132/33 kV power transformer circuits including transformer tap changer control.
- 1F15 Control, Protection & Monitoring and Substation Automation System including event recording function for one(1) set of bus coupler circuit.
- 1F16 One (1) set of Busbar protection for 132kV system
- 1F17 One (1) set of Independent standalone Digital Fault and Disturbance recorder (DFDR) to monitor all bays.
- 1F18 One (1) lot of Tariff metering panel to accommodate programmable & recordable digital 3-phase, 4-wire import and export MWh and MVARhmeters (accuracy class 0.2) for each 132 kV line and transformer feeder. For each feeder minimum two meters (main & check) including one set software and communication cord. Substation Automation System shall include the metering for all the bays. Tariff Metering is to be supplied from Europe, Canada, USA or Japan origin. Printed catalogue, operation and service manual are to be provided.

### 33kV Station Power System

1F19 One (1) lot of Control, Protection & Monitoring and Substation Automation System including event recording function for two 33kV circuits connected between tertiary side of 400/230/33kV Power transformers and two sets of 33/0.415 kV station Auxiliary Transformers.

1F20 One (1) lot of Tariff metering panel to accommodate programmable & recordable digital 3-phase, 4-wire import and export MWh and MVarh meters (accuracy class 0.2) for each 33 kV transformer feeder. For each feeder minimum two meters (main & check) including one set software and communication cord. Substation Automation System shall include the metering for all the bays. Tariff Metering is to be supplied from BPDB approved make. Printed catalogue, operation and service manual are to be provided.

## **1G Multicore Cables**

1G1 One(1) lot complete setof multicore low voltage XLPE insulated power and control cables (IEC 60502) shall be supplied, installed, glanded, terminated and have individual cores identified to be used for connection of all equipment supplied under the Contract. The overall substation cable routing and core schedules shall also be provided. Necessary Sizing calculation shall have to be submitted for approval during execution stage.

## **1H Earthing and Lightning Protection**

1H1 One (1) lot of design, supply and installation of earthing system for outdoor switchyard equipment & Control Room with necessary connectors and clamps, with design to suit the work under this contract arrangement. Calculation and GPR shall have to show using software like CYMGRD.

1H2 One (1) lot of design, supply and installation of lightning protection screen for outdoor switchyard equipment & Control Room with necessary connectors and clamps, with design to suit the work under this project. Supporting calculation shall have to be shown in Rolling Sphere method.

## **1I Batteries, Chargers and DC Distribution**

1I1 110V substation alkaline batteries complete with chargers and distribution switchboard to be supplied, installed and commissioned to provide all DC supplies to equipment being supplied.

The system shall generally be as shown in bid drawing and shall include:

a) 400KV System:

i)Two (2) sets of 100% batteries complete, each capacity shall not be less than 350Ah at the 5-hour rate of discharge for 400kV switchyard.

During execution stage the battery capacity shall be confirmed with calculation by the contractor considering international standards for the bays under scope of work and future bays as per clause 8.4.3 of section 8 of Volume 2 of 3 of the bidding document. The battery with higher capability if required after calculation shall be supplied by the Contractor within the same Contract price.

ii)Two (2) sets of battery chargers complete, each charge shall not be less than 130A rating and input voltage three phase 50Hz, 415V AC.for 400kV switchyard.

Batteries and battery chargers shall be located in the 400kV #1 local control house and shall be used for first main and second main DC supplies for 400kV switchyard. The charger rating shall be based on the load & boost charging rate and during execution stage after calculation if the higher charging charger is found to be required, it shall be supplied by the Contractor within the same Contract price.

iii)One(1) lot of DC distribution board. The DC distribution board shall be with overall spare switches for future use.

All DC status excluding (DC voltage status for each bus including coupling breaker on/off status, fail with alarm, status of DC MCB/MCCB at SPR with fail alarm etc.) control & protection shall be incorporated in substation automation system.

**b) 230KV System:**

i)Two (2) sets of 100% batteries complete, each capacity shall not be less than 300Ah at the 5-hour rate of discharge for 230kV switchyard.

During execution stage the battery capacity shall be confirmed with calculation by the contractor considering international standards for the bays under scope of work and future bays as per clause 8.4.3 of section 8 of Volume 2 of 3 of the bidding document. The battery with higher capability if required after calculation shall be supplied by the Contractor within the same Contract price.

ii)Two (2) sets of battery chargers complete, each charge shall not be less than 100A rating and input voltage three phase 50Hz, 415V AC.for 230kV switchyard.

One set shall be used for DC supplies for 230kV switchyard and the other set shall be used for standby (emergency) DC supplies for 230kV switchyard. The charger rating shall be based on the load & boost charging rate and during execution stage after calculation if the higher charging charger is found to be required, it shall be supplied by the Contractor within the same Contract price.

iii)One(1) lot of DC distribution board. The DC distribution board shall be with overall spare switches for future use.

All DC status excluding (DC voltage status for each bus including coupling breaker on/off status, fail with alarm, status of DC MCB/MCCB at SPR with fail alarm etc.) control & protection shall be incorporated in substation automation system.

iv) Two (2) sets of Inverter for SAS from 110V DC system having rating of Online 240V, 50Hz, 3kVA Inverter from 110V DC distribution board and AC distribution board as bypass circuit for substation automation system.

c) 132KV System:

i)Two (2) sets of 100% batteries complete, each capacity shall not be less than 300Ah at the 5-hour rate of discharge for 132kV switchyard.

During execution stage the battery capacity shall be confirmed with calculation by the contractor considering international standards for the bays under scope of work and future bays as per clause 8.4.3 of section 8 of Volume 2 of 3 of the bidding document. The battery with higher capability if required after calculation shall be supplied by the Contractor within the same Contract price.

ii)Two (2) sets of battery chargers complete, each charge shall not be less than 100A rating and input voltage three phase 50Hz, 415V AC.for 132kV switchyard.

One set shall be used for DC supplies for 132kV switchyard and the other set shall be used for standby (emergency) DC supplies for 132kV switchyard. The charger rating shall be based on the load & boost charging rate and during execution stage after calculation if the higher charging charger is found to be required, it shall be supplied by the Contractor within the same Contract price.

iii)One(1) lot of DC distribution board. The DC distribution board shall be with overall spare switches for future use.

All DC status excluding (DC voltage status for each bus including coupling breaker on/off status, fail with alarm, status of DC MCB/MCCB at SPR with fail alarm etc.) control & protection shall be incorporated in substation automation system.

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48V DC system and distribution equipment to be supplied, installed and commissioned in the main control building for the new fibre optic multiplexer equipment for communication and protection. One set shall be used as standby supply. 48V DC system and distribution equipment shall be located in the Main Control Building.

The system shall generally be as shown in bid drawing and shall include:

i)Two (2) sets of 100% batteries complete, each capacity shall not be less than 250Ah at the 5-hour rate of discharge for for communication and protection.

During execution stage the battery capacity shall be confirmed with calculation by the contractor considering international standards for the bays under scope of work and future bays as per clause 8.4.3 of section 8 of Volume 2 of 3 of the bidding document. The battery with higher capability if required after calculation shall be supplied by the Contractor within the same Contract price.

ii)Two (2) sets of battery chargers complete, each charge shall not be less than 100A rating and input voltage three phase 50Hz, 415V AC..

One set shall be used for DC supplies and the other set shall be used for standby (emergency) DC supplies. The charger rating shall be based on the load & boost charging rate and during execution stage after calculation if the higher charging charger is found to be required, it shall be supplied by the Contractor within the same Contract price.

iii)One(1) lot of DC distribution board. The DC distribution board shall be with overall spare switches for future use.

All DC status excluding (DC voltage status for each bus including coupling breaker on/off status, fail with alarm, status of DC MCB/MCCB at SPR with fail alarm etc.) control & protection shall be incorporated in substation automation system.

## **1J LVAC Distribution**

1J1 One(1) lot of LVAC switchboard for substation services to be supplied, installed and commissioned, to provide the 415/240V supplies to all equipment being supplied under this turnkey Bid.

All AC status excluding control & protection (AC voltage status for each bus including coupling breaker on/off status, fail with alarm, status of AC MCB/MCCB at SPR with fail alarm etc.) shall be incorporated in substation automation system.

1J2 One(1) lot of Tariff metering panel to accommodate programmable & recordable digital 3-phase, 4-wire import and export MWh and MVArh meters (accuracy class 0.2) for three 33/0.415 kV station auxiliary transformer feeder circuits. For each feeder minimum two meters (main & check) shall have to be supplied. **Tariff meter shall be BPDB approved make.**

The system and requirements shall generally be as shown in Bid drawing and technical specification of Volume 2 and shall include one 125A outdoor weather-proof 3-phase with

neutral and earth switched socket outlet and plug as per IEC 309; to be installed, cabled and connected adjacent to the auxiliary transformers.

## **1K Civil Works, Building and Foundation**

1K1 Land development of complete switchyard area by cutting, land filling, compacting up to a suitable level including slope protection.

1K2 One(1) lot of complete design, supply and construction of all civil items required for the outdoor works suitable for switchyard gantry & equipment foundations, transformer foundations, blast walls, oil pit, entrance & internal roads, cable trenches, septic tank, surfacing, drainage, fences, guard house, boundary wall , gravel laying, sentry post, ansar barac etc.

1K3 One(1) lot of complete design, supply and construction of all civil items and facilities required for a new three storied Main Control Room Building, two(2) nos one storied switchyard panel room in 400kV switchyard and one nos one storied switchyard panel room in 132kV switchyard

1K4 Testing of pile Foundation , Compression & uplift on random basis.

1K5 One (1) lot of complete design, supply and construction of firefighting system for transformers including water pipe network and reservoir at normal pressure. Necessary Sizing calculation shall have to be submitted for approval during execution stage.

## **1L Lighting, Small Power, Air Conditioning and Ventilation**

1L1 One(1) lot of complete design, supply, installation and commissioning of equipment to provide lighting, LV power supply, air conditioning system, ventilation system and emergency DC lighting system for the main control building and local control houses. Necessary Sizing calculation with software shall have to be submitted for approval during execution stage.

1L2 One(1) lot of complete set of design, supply, installation and commissioning of equipment to provide lighting (flood light; sodium/mercury) for security, roadway, switchyard and emergency DC lighting system at strategic locations for equipment operation and inspection.Necessary Sizing calculation with software shall have to be submitted for approval during execution stage.

1L3 Complete Solar system (40KW solar panel) including VRLA maintenance free battery (min 5 hours backup) with inverter & changeover facilities including other accessories for substation lighting.

**1M Fibre Optic Multiplexer Equipment for Communication and Protection**

1M1 The equipment to be supplied, installed and commissioned shall be as shown on bid drawing. One(1) lot complete set of design, supply, installation and commissioning of fibre optic multiplexer equipment including necessary works to interface with existing system is to be provided for:

- 87 or 21 relay (main and back-up) for each transmission line protection (through fibre cores)
- 21 relay carrier signal (main and back-up)
- SCADA data from switchgear and control system
- Hot-line telephone system

1M2 Underground optical fibre cables (48 cores for 400kV and 48 cores for 230kV and 24cores for 132kV switchyard) from terminal box gantry structure at each 400kV & 230KV & 132kV double circuit transmission line termination point to MDF (Main distribution Frame) to be installed in control room. The Contract includes supply and installation of MDF and pigtail cables with adequate length.

**1M3 PLC Equipment:**

The equipment to be supplied, installed and commissioned shall be as per the SLD.  
The scope of supply is summarised as follows:-

**400kV**

4 sets:- Indoor PLC equipment including tele-protection at PEKUA for (direction Matarbari 1 & 2 and Bashkhali 1 & 2) 400 kV line.

12 nos.:- line matching units for phase to phase circuit coupling for 400kV lines.

Additionally, if any Interfaces are required for system configuration at each remote end substation, then interface devices shall be installed in each existing system as a lot.

**1N SCADA system for Telecontrol and Telemetry**

- 1N1 One(1) lot of complete design, supply, delivery, installation, testing & commissioning of hardware and software to provide the telecontrol & telemetering facilities required at the existing National Load Despatch Center(NLDC) at Rampura for integration of complete new 400/230/132kV substation. All required electrical signals shall be transmitted to the NLDC through the Industrial Gateway of the substation automation system. All HV breakers, motorized disconnectors, tap changer, etc. shall be controlled form NLDC through the Gateway of the substation automation system using IEC 60870-5-101 protocol. All necessary modification works in the software of master station of NLDC are to be carried out.

**Section-II**      **Mandatory Spare parts including Maintenance Equipment**

Supply of complete spares and spare parts of transformer, switchgear, control equipment, protection relays, meters, & erection as per quantity mentioned in Schedule B of price schedule. The materials shall have to be handed over to the designated store as per instruction of the Engineer. Spare shall be supplied from main item make.

# **POWER GRID BANGLADESH PLC**

## **BIDDING DOCUMENT**

### **FOR**

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]**

## **SCHEDULE B**

### **BID PRICES**

## **POWER GRID BANGLADESH PLC**

### **BIDDING DOCUMENT**

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]**

### **SCHEDULE B (PRICE SCHEDULES)**

#### **PREAMBLE**

##### **General**

1. The Price Schedules are divided into separate Schedules as follows & added in Section 4 of Volume 1:

Schedule No. B1: Plant Supplied from outside the Employer's Country.

Schedule No. B2: Plant Supplied from within the Employer's Country.

Schedule No. B3: Design Services( Not applicable)

Schedule No. B4: Installation & other services.

Schedule No. B5: Summary of price schedule

2. The Schedules do not generally give a full description of the plant to be supplied and the services to be performed under each item. Bidders shall be deemed to have read the Employer's Requirements and other sections of the Bidding Document and reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling in the rates and prices. The entered rates and prices shall be deemed to cover the full scope as aforesaid, including overheads and profit.
3. If bidders are unclear or uncertain as to the scope of any item, they shall seek clarification in accordance with ITB 7 prior to submitting their bid.

## SCHEDULE B

### **Pricing**

4. Prices shall be filled in indelible ink, and any alterations necessary due to errors, etc., shall be initialed by the Bidder.

As specified in the Bid Data Sheet and Special Conditions of Contract, prices shall be fixed and firm for the duration of the Contract.

5. Bid prices shall be quoted in the manner indicated and in the currencies specified in the Instructions to Bidders in the Bidding Document.

For each item, bidders shall complete each appropriate column in the respective Schedules, giving the price breakdown as indicated in the Schedules.

Prices given in the Schedules against each item shall be for the scope covered by that item as detailed in Section 6 (Employer's Requirements) or elsewhere in the Bidding Document.

6. Payments will be made to the Contractor in the currency or currencies indicated under each respective item.
7. When requested by the Employer for the purposes of making payments or partial payments, valuing variations or evaluating claims, or for such other purposes as the Employer may reasonably require, the Contractor shall provide the Employer with a breakdown of any composite or lump sum items included in the Schedules.

### **Notes**

- i. Items identified as lot in price schedule shall include all the materials required for proper completion of work against that item.
- ii. Items identified as meters, such as Cable, GIL, GIB etc. shall be deemed to be tentative & based on preliminary design which shall be variable during detail design in execution stage. Hence, payment shall be on actual basis, but the unit price shall remain constant throughout the contract.
- iii. Items identified as Cubic feet or meters, such as land/earth filling etc. shall be deemed to be tentative & based on preliminary estimation which shall be variable during execution stage. Hence, payment shall be on actual basis, but the unit price shall remain constant throughout the contract.

## SCHEDULE B

- iv. For Items under steel gantry, column & beam has been added as number basis so that payment can be made on actual basis if no. of column changes during detail Engineering in Execution stage while unit price shall remain fixed.
- v. Equipment support structure& foundation for Transformer, switchgear etc has been added on Number basis based on tentative & preliminary design so that payment can be made on actual basis if no. of structure changes during detail Engineering in Execution stage while unit price shall remain fixed.

# **POWER GRID BANGLADESH PLC**

## **BIDDING DOCUMENT**

### **FOR**

### **Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit/132kV LILO Lines on turnkey basis (Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-  
Tender]**

## **SCHEDULE C**

### **Bar Chart Program of Key Activities-Delivery & Completion Time Schedule**

The Bidder shall fill, sign and stamp the attached time schedule and shall attach it to the tender. Time for completion of the whole facilities is 900 (Nine Hundred Twenty) days from the effective date as described in Section 8 - Special Conditions of Contract, Sub-Clause 8.2.

The Bidder shall provide

- filled general time schedule, provided below and as Appendix 4 to the Section 9: Contract Forms,
- a detailed proposal for mobilization schedule, Section 4: Tendering forms, item 5.3. and
- a detailed proposal for the construction schedule, Section 4: Tendering forms, item 5.4.

Please find the time schedule attached.

[illegible]

## POWER GRID BANGLADESH PLC

### BIDDING DOCUMENT FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS  
Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO  
Lines on turnkey basis (Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-  
Tender]**

### SCHEDULE D

#### MANUFACTURERS, PLACES OF MANUFACTURE

The following Subcontractors and/or manufacturers are proposed for carrying out the item of the facilities indicated.

Bidders are free to propose more than one for each item.

For all proposed manufacturer, bidders are requested to complete the corresponding technical particular forms.

| Item | Description                                                                                                                                                                                                                              | Proposed Subcontractors/<br>Manufacturers | Place of<br>Manufacture |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|-------------------------|
| 1    | <b>420 kV AIS SWITCHGEAR (As per<br/>Volume 1: Section 3 -EQC)</b><br><br>AIS Circuit Breaker<br><br>AIS Disconnecter Switch<br><br>Current Transformer<br><br>Capacitive Voltage Transformer<br><br>Surge Arrester<br><br>AIS Wave Trap |                                           |                         |
| 2    | <b>245 kV AIS SWITCHGEAR (As per<br/>Volume 1: Section 3 -EQC)</b><br><br>AIS Circuit Breaker                                                                                                                                            |                                           |                         |

| Item | Description                                                               | Proposed Subcontractors/<br>Manufacturers | Place of Manufacture |
|------|---------------------------------------------------------------------------|-------------------------------------------|----------------------|
| 3    | AIS Disconnecter Switch                                                   |                                           |                      |
|      | Current Transformer                                                       |                                           |                      |
|      | Capacitive Voltage Transformer                                            |                                           |                      |
|      | Surge Arrester                                                            |                                           |                      |
|      | <b>145 kV AIS SWITCHGEAR (As per Volume 1: Section 3 -EQC)</b>            |                                           |                      |
|      | AIS Circuit Breaker                                                       |                                           |                      |
| 4    | AIS Disconnecter Switch                                                   |                                           |                      |
|      | Current Transformer                                                       |                                           |                      |
|      | Inductive Voltage Transformer                                             |                                           |                      |
|      | Surge Arrester                                                            |                                           |                      |
|      | <b>33kV AIS SWITCHGEAR (<u>same as 145kV Switchgear</u>)</b>              |                                           |                      |
|      | AIS Circuit Breaker                                                       |                                           |                      |
| 5    | AIS Disconnecter Switch                                                   |                                           |                      |
|      | Current Transformer                                                       |                                           |                      |
|      | Voltage Transformer                                                       |                                           |                      |
|      | Surge Arrester                                                            |                                           |                      |
|      | <b>400/230/33 kV POWER TRANSFORMERS (As per Volume 1: Section 3 -EQC)</b> |                                           |                      |
|      | Complete [except bushing and OLTC]                                        |                                           |                      |
|      | On Load Tap Changer (OLTC) [ <u>as per specification requirement</u> ]    |                                           |                      |
|      | Bushing [ <u>as per specification requirement</u> ]                       |                                           |                      |
|      |                                                                           |                                           |                      |

| Item | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Proposed Subcontractors/<br>Manufacturers | Place of<br>Manufacture |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|-------------------------|
| 6    | <p><b>230/132/33 kV POWER TRANSFORMERS (As per Volume 1: Section 3 -EQC)</b></p> <p>Complete [except bushing and OLTC]</p> <p>On Load Tap Changer (OLTC) [<u>as per specification requirement</u>]</p> <p>Bushing [<u>as per specification requirement</u>]</p>                                                                                                                                                                                              |                                           |                         |
| 7    | <p><b>PROTECTION, METERING AND CONTROL (<u>As per specification requirement and Volume 1: Section 3 -EQC</u>)</b></p> <p>Line Protection relays (Main-1)</p> <p>Line Protection relays (Main-2)</p> <p>Transformer protection relay (Main-1)</p> <p>Transformer protection relay (Main-2)</p> <p>Busbar protection relay (Main-1)</p> <p>Busbar protection relay (Main-2 for 400kV)</p> <p>Bay Control Unit (BCU), Switches, Servers, OWS, EWS, Gateway,</p> |                                           |                         |
| 8    | <p><b>Communication Equipment (<u>As per specification requirement and Volume 1: Section 3 -EQC</u>)</b></p> <p>Fiber Optic Multiplexer</p> <p>Power Line Carrier (PLC)</p> <p>Line Matching Unit (LMU)</p>                                                                                                                                                                                                                                                  |                                           |                         |

Schedule D: Manufactures, place of manufacture and testing

| Item | Description                                                                                                                                     | Proposed Subcontractors/<br>Manufacturers | Place of Manufacture |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------|
| 9    | Tele-protection<br><b>Digital Fault and Disturbance Recorder (DFDR) (<u>As per specification requirement and Volume 1: Section 3 - EQC</u>)</b> |                                           |                      |
| 10   | <b>Disc Insulator (As per Volume 1: Section3 -EQC)</b>                                                                                          |                                           |                      |
| 11   | <b>Battery (As per Volume 1: Section 3 -EQC)</b>                                                                                                |                                           |                      |
| 12   | <b>Battery Charger (As per Volume 1: Section 3 -EQC)</b>                                                                                        |                                           |                      |
| 13   | <b>Energy (Tariff) meter (<u>As per specification requirement</u>)</b>                                                                          |                                           |                      |

For remaining items, the bidders shall propose reputed make with supply record and type test report (if applicable) during Contract execution stage.

# POWER GRID BANGLADESH PLC

## BIDDING DOCUMENT

### FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]  
SCHEDULE E**

## 1. TECHNICAL PARTICULARS AND GUARANTEES

### PART 1 - SWITCHGEAR

#### 1.1 EHV OUTDOOR AIS CIRCUIT BREAKERS

##### 1.1.1 420KV CIRCUIT BREAKERS

[Technical particulars and guarantees shall be filled separately for different manufacturers]

| Sl. No. | Description                                                      | Unit    | Minimum Requirements                   | Guaranteed Technical particulars |
|---------|------------------------------------------------------------------|---------|----------------------------------------|----------------------------------|
| 1.      | Manufacturer [ also mentioned in Schedule D]                     |         | [insert]                               |                                  |
| 2.      | Manufacturer's country of origin [ also mentioned in Schedule D] |         | [insert]                               |                                  |
| 3.      | Manufacturer Address                                             |         | [insert]                               |                                  |
| 4.      | Model Reference (Manufacturer's designation)                     |         | [insert]                               |                                  |
| 5.      | Type                                                             |         | Outdoor, SF6 insulated, live tank type |                                  |
| 6.      | Applicable Standard                                              |         | IEC 62271-100                          | IEC 62271-100                    |
| 7.      | System Earthing                                                  |         | Effectively earthing                   | Effectively earthing             |
| 8.      | Max System Voltage (Um)                                          | kV rms  | 420 kV                                 |                                  |
| 9.      | Nominal Voltage                                                  | kV rms  | 400 kV                                 |                                  |
| 10.     | Min. Rated voltage (Ur)                                          | kV rms  | 420 kV                                 |                                  |
| 11.     | Min. Rated short-duration power frequency withstand voltage (Ud) |         |                                        |                                  |
|         | (a) Phase-to-earth and between phases                            | kV rms  | 520 kV rms                             |                                  |
|         | (b) Across open switching device and/or isolating distance       | kV rms  | 610 kV rms                             |                                  |
| 12.     | Min. Rated switching impulse withstand voltage (Us)              |         |                                        |                                  |
|         | (a) Phase-to earth and across open switching Device              | kV peak | 1050                                   |                                  |

SE-1

Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)

| Sl. No. | Description                                         | Unit    | Minimum Requirements                      | Guaranteed Technical particulars |
|---------|-----------------------------------------------------|---------|-------------------------------------------|----------------------------------|
|         | (b) Across isolating distance                       | kV peak | 900 (+345) kV peak                        |                                  |
| 13.     | Min. Rated lightning impulse withstand voltage (Up) |         |                                           |                                  |
|         | (a) Phase-to earth and between phases               | kV peak | 1425                                      |                                  |
|         | (b) Between terminals with CB open                  | kV peak | 1425 (+240)                               |                                  |
| 14.     | Rated frequency (fr)                                | Hz      | 50                                        | 50                               |
| 15.     | Min. Rated continuous current (Ir)                  |         |                                           |                                  |
|         | (a) Line bay                                        | A       | 4000                                      |                                  |
|         | (b) Transformer bay                                 | A       | 4000                                      |                                  |
|         | (c) Bus coupler/ sectionalizer/Mid breaker          | A       | 4000                                      |                                  |
| 16.     | Min. Rated short-time withstand current (Ik)        | kA rms  | 63                                        |                                  |
| 17.     | Min. Rated duration of short-circuit (tk)           | s       | 1                                         |                                  |
| 18.     | Min. Rated peak withstand current (Ip)              | kA peak | 157.5                                     |                                  |
| 19.     | Rated First pole to clear factor (kpp)              |         | 1.3                                       |                                  |
| 20.     | Min. Rated short circuit breaking current           | kA rms  | 63                                        |                                  |
| 21.     | Min. Rated short circuit making current             | kA peak | 157.5                                     |                                  |
| 22.     | Max. radio interference voltage                     | uv      | 1000                                      |                                  |
| 23.     | Mechanical Endurance Class                          |         | M2                                        |                                  |
| 24.     | Total closing time                                  | Ms      | Not more than 150 ms                      |                                  |
| 25.     | Total breaking time                                 | ms      | Not more than 45 ms                       |                                  |
| 26.     | Operating mechanism                                 |         | Motor spring stored energy                |                                  |
| 27.     | Rated operating sequence                            |         | O-0.3s-CO-3min-CO                         |                                  |
| 28.     | Reclosing                                           |         | Single phase & Three phase auto-reclosing |                                  |
| 29.     | Trip free/or fixed trip                             |         | Trip free                                 |                                  |
| 30.     | Insulator type                                      |         | Porcelain                                 |                                  |
| 31.     | Min. Insulator Creepage distance                    |         | 25 mm/kV                                  |                                  |
| 32.     | Number of closing coils                             | No.     | 1                                         |                                  |
|         | Supply voltage                                      | V       | 110V DC                                   |                                  |
|         | Power                                               | W       | [insert]                                  |                                  |
| 33.     | Number of tripping coils                            | No.     | 2                                         |                                  |
|         | Supply voltage                                      | V       | 110V DC                                   |                                  |
|         | Power                                               | W       | [insert]                                  |                                  |
| 34.     | Number of auxiliary switch contacts                 |         |                                           |                                  |
|         | - normally open                                     |         | Min. 12                                   |                                  |
|         | - normally closed                                   |         | Min. 12                                   |                                  |
|         | - adjustable                                        |         | [insert]                                  |                                  |

| Sl. No. | Description                                                                                                                          | Unit                       | Minimum Requirements                         | Guaranteed Technical particulars |
|---------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------------------------|----------------------------------|
| 35.     | Ingression Protection class                                                                                                          |                            | IP55                                         |                                  |
| 36.     | Number of Poles in set (3 phase)                                                                                                     | No.                        | 3                                            |                                  |
| 37.     | Number of interrupter /poles                                                                                                         | No.                        | 2                                            |                                  |
| 38.     | Rated breaking currents:<br>Line charging<br>Cable charging<br>Small inductive                                                       | kA rms<br>kA rms<br>kA rms | As per IEC                                   |                                  |
| 39.     | Rated transient recovery voltage for terminal faults if other than standard                                                          | kV                         | As per IEC                                   |                                  |
| 40.     | Rated characteristics for short-line faults                                                                                          |                            | As per IEC                                   |                                  |
| 41.     | Rated out of phase breaking current                                                                                                  | kA                         | As per IEC                                   |                                  |
| 42.     | Is circuit-breaker re-strike free?                                                                                                   | Yes/No                     | Yes                                          |                                  |
| 43.     | Rated supply pressure of gas for interruption                                                                                        | MPa (g)                    | [insert]                                     |                                  |
| 44.     | Limits for correct operation<br><br>max<br>min                                                                                       | MPa (g)<br>MPa (g)         | [insert]<br>[insert]                         |                                  |
| 45.     | Is lockout facility fitted?                                                                                                          | Yes/No                     | Yes                                          |                                  |
| 46.     | Other auxiliary loads (Heater and Light):<br><br>Voltage:<br><br>Power                                                               | V<br><br>W                 | 230V AC<br><br>[insert]                      |                                  |
| 47.     | Minimum clearances in air:<br>(a) between phases<br>(b) phases to earth<br>(c) across interrupters<br>(d) live parts to ground level | mm<br>mm<br>mm<br>mm       | [insert]<br>[insert]<br>[insert]<br>[insert] |                                  |
| 48.     | Guaranteed maximum gas leakage                                                                                                       | % per annum                | [insert]                                     |                                  |
| 49.     | Weight of circuit-breaker unit complete                                                                                              | kg                         | [insert]                                     |                                  |
| 50.     | Grading capacitance included                                                                                                         |                            | Yes/No                                       |                                  |
| 51.     | Value of grading capacitance                                                                                                         | pF                         | [insert]                                     |                                  |
| 52.     | Value Pre insertion Resistor (PIR) [if applicable for 400kV as per schedule A and SLD]                                               | Ohm/ph<br>ase              | 400                                          |                                  |
| 53.     | Min Pre-insertion time for PIR ) [if applicable for 400kV as per schedule A and SLD]                                                 | ms                         | 8                                            |                                  |
| 54.     | Model of CSD (Control Switching Device) [if applicable for 400kV as per schedule A and SLD]                                          |                            | [insert]                                     |                                  |
| 55.     | Operating Voltage of CSD (Control Switching Device) [if applicable for 400kV as per schedule A and SLD]                              | V DC                       | 110                                          |                                  |

**1.1.2 230KV CIRCUIT BREAKERS**

[Technical particulars and guarantees shall be filled separately for different manufacturers]

| Sl. No. | Description                                                      | Unit    | Minimum Requirements                   | Guaranteed Technical particulars |
|---------|------------------------------------------------------------------|---------|----------------------------------------|----------------------------------|
| 1.      | Manufacturer [ also mentioned in Schedule D]                     |         | [insert]                               |                                  |
| 2.      | Manufacturer's country of origin [ also mentioned in Schedule D] |         | [insert]                               |                                  |
| 3.      | Manufacturer Address                                             |         | [insert]                               |                                  |
| 4.      | Model Reference (Manufacturer's designation)                     |         | [insert]                               |                                  |
| 5.      | Type                                                             |         | Outdoor, SF6 insulated, live tank type |                                  |
| 6.      | Applicable Standard                                              |         | IEC 62271-100                          | IEC 62271-100                    |
| 7.      | System Earthing                                                  |         | Effectively earthing                   | Effectively earthing             |
| 8.      | Max System Voltage (Um)                                          | kV rms  | 245 kV                                 |                                  |
| 9.      | Nominal Voltage                                                  | kV rms  | 230 kV                                 |                                  |
| 10.     | Min. Rated voltage (Ur)                                          | kV rms  | 245 kV                                 |                                  |
| 11.     | Min. Rated short-duration power frequency withstand voltage (Ud) |         |                                        |                                  |
|         | (c) Phase to-earth and between phases                            | kV rms  | 460 kV rms                             |                                  |
|         | (d) Across open switching device and/or isolating distance       | kV rms  | 460 kV rms                             |                                  |
| 12.     | Min. Rated lightning impulse withstand voltage (Up)              |         |                                        |                                  |
|         | (c) Phase-to earth and between phases                            | kV peak | 1050                                   |                                  |
|         | (d) Between terminals with CB open                               | kV peak | 1050                                   |                                  |
| 13.     | Rated frequency (fr)                                             | Hz      | 50                                     | 50                               |
| 14.     | Min. Rated continuous current (Ir)                               |         |                                        |                                  |
|         | (d) Line bay                                                     | A       | 2000                                   |                                  |
|         | (e) Transformer bay                                              | A       | 2000                                   |                                  |
|         | (f) Bus coupler/ sectionalizer/Mid breaker                       | A       | 3150                                   |                                  |
| 15.     | Min. Rated short-time withstand current (Ik)                     | kA rms  | 50                                     |                                  |
| 16.     | Min. Rated duration of short-circuit (tk)                        | s       | 1                                      |                                  |
| 17.     | Min. Rated peak withstand current (Ip)                           | kA peak | 125                                    |                                  |
| 18.     | Rated First pole to clear factor (kpp)                           |         | 1.3                                    |                                  |
| 19.     | Min. Rated short circuit breaking current                        | kA rms  | 50                                     |                                  |
| 20.     | Min. Rated short circuit making current                          | kA peak | 125                                    |                                  |
| 21.     | Max. radio interference voltage                                  | uv      | 1000                                   |                                  |
| 22.     | Total closing time                                               | Ms      | Not more than 200 ms                   |                                  |

| Sl. No. | Description                                                                                 | Unit                       | Minimum Requirements                      | Guaranteed Technical particulars |
|---------|---------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------|----------------------------------|
| 23.     | Total breaking time                                                                         | ms                         | Not more than 65 ms                       |                                  |
| 24.     | Mechanical Endurance Class                                                                  |                            | M2                                        |                                  |
| 25.     | Operating mechanism                                                                         |                            | Motor spring stored energy                |                                  |
| 26.     | Rated operating sequence                                                                    |                            | O-0.3s-CO-3min-CO                         |                                  |
| 27.     | Reclosing                                                                                   |                            | Single phase & Three phase auto-reclosing |                                  |
| 28.     | Trip free/or fixed trip                                                                     |                            | Trip free                                 |                                  |
| 29.     | Insulator type                                                                              |                            | Porcelain                                 |                                  |
| 30.     | Min. Insulator Creepage distance                                                            |                            | 25 mm/kV                                  |                                  |
| 31.     | Number of closing coils                                                                     | No.                        | 1                                         |                                  |
|         | Supply voltage                                                                              | V                          | 110V DC                                   |                                  |
|         | Power                                                                                       | W                          | [insert]                                  |                                  |
| 32.     | Number of tripping coils                                                                    | No.                        | 2                                         |                                  |
|         | Supply voltage                                                                              | V                          | 110V DC                                   |                                  |
|         | Power                                                                                       | W                          | [insert]                                  |                                  |
| 33.     | Number of auxiliary switch contacts<br>- normally open<br>- normally closed<br>- adjustable |                            | Min. 12<br>Min. 12<br>[insert]            |                                  |
| 34.     | Ingression Protection class                                                                 |                            | IP55                                      |                                  |
| 35.     | Number of Poles in set (3 phase)                                                            | No.                        | 3                                         |                                  |
| 36.     | Number of interrupter /poles                                                                | No.                        | 1                                         |                                  |
| 37.     | Rated breaking currents:<br>Line charging<br>Cable charging<br>Small inductive              | kA rms<br>kA rms<br>kA rms | As per IEC                                |                                  |
| 38.     | Rated transient recovery voltage for terminal faults if other than standard                 | kV                         | As per IEC                                |                                  |
| 39.     | Rated characteristics for short-line faults                                                 |                            | As per IEC                                |                                  |
| 40.     | Rated out of phase breaking current                                                         | kA                         | As per IEC                                |                                  |
| 41.     | Is circuit-breaker re-strike free?                                                          | Yes/No                     | Yes                                       |                                  |
| 42.     | Rated supply pressure of gas for interruption                                               | MPa (g)                    | [insert]                                  |                                  |
| 43.     | Limits for correct operation<br><br>max<br>min                                              | MPa (g)<br>MPa (g)         | [insert]<br>[insert]                      |                                  |
| 44.     | Is lockout facility fitted?                                                                 | Yes/No                     | Yes                                       |                                  |
| 45.     | Other auxiliary loads (Heater and Light):<br><br>Voltage:                                   | V                          | 230V AC                                   |                                  |

| Sl. No. | Description                                                                                                                          | Unit                 | Minimum Requirements                         | Guaranteed Technical particulars |
|---------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------------------------|----------------------------------|
|         | Power                                                                                                                                | W                    | [insert]                                     |                                  |
| 46.     | Minimum clearances in air:<br>(a) between phases<br>(b) phases to earth<br>(c) across interrupters<br>(d) live parts to ground level | mm<br>mm<br>mm<br>mm | [insert]<br>[insert]<br>[insert]<br>[insert] |                                  |
| 47.     | Guaranteed maximum gas leakage                                                                                                       | % per annum          | [insert]                                     |                                  |
| 48.     | Weight of circuit-breaker unit complete                                                                                              | kg                   | [insert]                                     |                                  |

### 1.1.3 145KV CIRCUIT BREAKERS

[Technical particulars and guarantees shall be filled separately for different manufacturers]

| Sl. No. | Description                                                                                                                                                                     | Unit                   | Minimum Requirements                   | Guaranteed Technical particulars |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------|----------------------------------|
| 1.      | Manufacturer [ also mentioned in Schedule D]                                                                                                                                    |                        | [insert]                               |                                  |
| 2.      | Manufacturer's country of origin [ also mentioned in Schedule D]                                                                                                                |                        | [insert]                               |                                  |
| 3.      | Manufacturer Address                                                                                                                                                            |                        | [insert]                               |                                  |
| 4.      | Model Reference (Manufacturer's designation)                                                                                                                                    |                        | [insert]                               |                                  |
| 5.      | Type                                                                                                                                                                            |                        | Outdoor, SF6 insulated, live tank type |                                  |
| 6.      | Applicable Standard                                                                                                                                                             |                        | IEC 62271-100                          | IEC 62271-100                    |
| 7.      | System Earthing                                                                                                                                                                 |                        | Effectively earthing                   | Effectively earthing             |
| 8.      | Max System Voltage (Um)                                                                                                                                                         | kV rms                 | 145 kV                                 |                                  |
| 9.      | Nominal Voltage                                                                                                                                                                 | kV rms                 | 132 kV                                 |                                  |
| 10.     | Min. Rated voltage (Ur)                                                                                                                                                         | kV rms                 | 145 kV                                 |                                  |
| 11.     | Min. Rated short-duration power frequency withstand voltage (Ud)<br><br>(e) Phase to-earth and between phases<br><br>(f) Across open switching device and/or isolating distance | kV rms<br><br>kV rms   | 275 kV rms<br><br>275 kV rms           |                                  |
| 12.     | Min. Rated lightning impulse withstand voltage (Up)<br><br>(e) Phase-to earth and between phases<br><br>(f) Between terminals with CB open                                      | kV peak<br><br>kV peak | 650<br><br>650                         |                                  |
| 13.     | Rated frequency (fr)                                                                                                                                                            | Hz                     | 50                                     | 50                               |
| 14.     | Min. Rated continuous current (Ir)<br>(g) Line bay                                                                                                                              | A                      | 1600                                   |                                  |

| Sl. No. | Description                                                                                 | Unit                       | Minimum Requirements                      | Guaranteed Technical particulars |
|---------|---------------------------------------------------------------------------------------------|----------------------------|-------------------------------------------|----------------------------------|
|         | (h) Transformer bay                                                                         | A                          | 1600                                      |                                  |
|         | (i) Bus coupler/ sectionalizer/Mid breaker                                                  | A                          | 3150                                      |                                  |
| 15.     | Min. Rated short-time withstand current (Ik)                                                | kA rms                     | 40                                        |                                  |
| 16.     | Min. Rated duration of short-circuit (tk)                                                   | s                          | 1                                         |                                  |
| 17.     | Min. Rated peak withstand current (Ip)                                                      | kA peak                    | 100                                       |                                  |
| 18.     | Rated First pole to clear factor (kpp)                                                      |                            | 1.3                                       |                                  |
| 19.     | Min. Rated short circuit breaking current                                                   | kA rms                     | 50                                        |                                  |
| 20.     | Min. Rated short circuit making current                                                     | kA peak                    | 100                                       |                                  |
| 21.     | Max. radio interference voltage                                                             | uv                         | 1000                                      |                                  |
| 22.     | Mechanical Endurance Class                                                                  |                            | M2                                        |                                  |
| 23.     | Total closing time                                                                          | Ms                         | Not more than 200 ms                      |                                  |
| 24.     | Total breaking time                                                                         | ms                         | Not more than 65 ms                       |                                  |
| 25.     | Operating mechanism                                                                         |                            | Motor spring stored energy                |                                  |
| 26.     | Rated operating sequence                                                                    |                            | O-0.3s-CO-3min-CO                         |                                  |
| 27.     | Reclosing                                                                                   |                            | Single phase & Three phase auto-reclosing |                                  |
| 28.     | Trip free/or fixed trip                                                                     |                            | Trip free                                 |                                  |
| 29.     | Insulator type                                                                              |                            | Porcelain                                 |                                  |
| 30.     | Min. Insulator Creepage distance                                                            |                            | 25 mm/kV                                  |                                  |
| 31.     | Number of closing coils                                                                     | No.                        | 1                                         |                                  |
|         | Supply voltage                                                                              | V                          | 110V DC                                   |                                  |
|         | Power                                                                                       | W                          | [insert]                                  |                                  |
| 32.     | Number of tripping coils                                                                    | No.                        | 2                                         |                                  |
|         | Supply voltage                                                                              | V                          | 110V DC                                   |                                  |
|         | Power                                                                                       | W                          | [insert]                                  |                                  |
| 33.     | Number of auxiliary switch contacts<br>- normally open<br>- normally closed<br>- adjustable |                            | Min. 12<br>Min. 12<br>[insert]            |                                  |
| 34.     | Ingression Protection class                                                                 |                            | IP55                                      |                                  |
| 35.     | Number of Poles in set (3 phase)                                                            | No.                        | 3                                         |                                  |
| 36.     | Number of interrupter /poles                                                                | No.                        | 1                                         |                                  |
| 37.     | Rated breaking currents:<br>Line charging<br>Cable charging<br>Small inductive              | kA rms<br>kA rms<br>kA rms | As per IEC                                |                                  |
| 38.     | Rated transient recovery voltage for terminal faults if other than standard                 | kV                         | As per IEC                                |                                  |
| 39.     | Rated characteristics for short-line faults                                                 |                            | As per IEC                                |                                  |

| Sl. No. | Description                                                                                                                          | Unit                 | Minimum Requirements                         | Guaranteed Technical particulars |
|---------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------------------------|----------------------------------|
| 40.     | Rated out of phase breaking current                                                                                                  | kA                   | As per IEC                                   |                                  |
| 41.     | Is circuit-breaker re-strike free?                                                                                                   | Yes/No               | Yes                                          |                                  |
| 42.     | Rated supply pressure of gas for interruption                                                                                        | MPa (g)              | [insert]                                     |                                  |
| 43.     | Limits for correct operation<br>max<br>min                                                                                           | MPa (g)<br>MPa (g)   | [insert]<br>[insert]                         |                                  |
| 44.     | Is lockout facility fitted?                                                                                                          | Yes/No               | Yes                                          |                                  |
| 45.     | Other auxiliary loads (Heater and Light):<br><br>Voltage:<br><br>Power                                                               | V<br><br>W           | 230V AC<br><br>[insert]                      |                                  |
| 46.     | Minimum clearances in air:<br>(a) between phases<br>(b) phases to earth<br>(c) across interrupters<br>(d) live parts to ground level | mm<br>mm<br>mm<br>mm | [insert]<br>[insert]<br>[insert]<br>[insert] |                                  |
| 47.     | Guaranteed maximum gas leakage                                                                                                       | % per annum          | [insert]                                     |                                  |
| 48.     | Weight of circuit-breaker unit complete                                                                                              | kg                   | [insert]                                     |                                  |

#### 1.1.4 33KV CIRCUIT BREAKERS

| Sl. No. | Description                                                                                                                                                                   | Unit | Minimum Requirements | Guaranteed Technical particulars |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------|----------------------------------|
|         |                                                                                                                                                                               |      | 36kV                 |                                  |
|         | Manufacturer & country of origin                                                                                                                                              |      |                      |                                  |
| 2.      | Model Reference (Manufacturer's designation)                                                                                                                                  |      |                      |                                  |
| 3.      | Type                                                                                                                                                                          |      | Outdoor type VCB     |                                  |
| 4.      | Standard                                                                                                                                                                      |      | IEC 62271-100        |                                  |
| 5.      | Rated voltage                                                                                                                                                                 |      | 36 kV                |                                  |
| 6.      | Rated short-duration power frequency withstand voltage (1 min.)<br>Between line terminal and ground<br>Between terminals with CB open<br>Between terminals with isolator open |      | 70 kV rms            |                                  |
| 7.      | Rated lightning impulse withstand voltage<br>- Between line terminal and ground<br>Between terminals with CB open                                                             |      | 170 kV peak          |                                  |
| 8.      | First pole to clear factor                                                                                                                                                    |      | 1.5                  |                                  |

| Sl. No | Description                                                                              | Unit   | Minimum Requirements       | Guaranteed Technical particulars |
|--------|------------------------------------------------------------------------------------------|--------|----------------------------|----------------------------------|
|        |                                                                                          |        | 36kV                       |                                  |
| 9.     | Rated short circuit breaking current                                                     |        | 31.5 kA rms                |                                  |
| 10.    | Rated short circuit making current                                                       |        | 65 kA peak                 |                                  |
| 11.    | Short time withstand current for 1 sec.                                                  |        | 31.5 kA rms                |                                  |
| 12.    | Corona extinction voltage with CB open or close                                          |        | N/A                        |                                  |
| 13.    | Max. radio interference voltage for frequency between 0.5MHz and 2MHz in all positions   |        |                            |                                  |
| 14.    | Total closing time                                                                       |        | Not more than 200 ms       |                                  |
| 15.    | Total breaking time                                                                      |        | 105 ms                     |                                  |
| 16.    | Operating mechanism                                                                      |        | Motor spring stored energy |                                  |
| 17.    | Rated duty cycle                                                                         |        | O-0.3s-CO-3min-CO          |                                  |
| 18.    | Reclosing                                                                                |        |                            |                                  |
| 19.    | Creepage distance                                                                        |        | 25 mm/kV                   |                                  |
| 20.    | Number of closing coils                                                                  |        | 1                          |                                  |
| 21.    | Number of tripping coils                                                                 |        | 2                          |                                  |
| 22.    | Number of auxiliary contacts for:<br>- Making<br>- Breaking<br>Middle position           |        | Min. 8<br>Min. 8<br>0      |                                  |
| 23.    | Ingression Protection class                                                              |        | IP55                       |                                  |
| 24.    | Number of Poles                                                                          |        | 3                          |                                  |
| 25.    | Rated frequency                                                                          | Hz     | 50                         |                                  |
| 26.    | Rated normal current-feeder/transformer/bus coupler<br>(As per schedule A scope of work) | A      |                            |                                  |
| 27.    | Rated breaking currents:<br>Line charging<br>Cable charging<br>Small inductive           | kA rms |                            |                                  |
| 28.    | Rated short-circuit breaking current                                                     | kA,rms |                            |                                  |
| 29.    | First pole to clear factor                                                               |        | 1.5 or 1.3                 |                                  |
| 30.    | Rated transient recovery voltage for terminal faults if other than standard              | kV     |                            |                                  |
| 31.    | Rated characteristics for short-line faults                                              |        |                            |                                  |
| 32.    | Rated short-circuit making current                                                       | kA     |                            |                                  |
| 33.    | Rated operating sequence                                                                 |        |                            |                                  |
| 34.    | Rated duration of short-circuit                                                          | s      | 1                          |                                  |
| 35.    | Rated out of phase breaking current                                                      | kA     |                            |                                  |
| 36.    | Is circuit-breaker re-strike free                                                        |        |                            |                                  |

| Sl. No. | Description                                                            | Unit               | Minimum Requirements | Guaranteed Technical particulars |
|---------|------------------------------------------------------------------------|--------------------|----------------------|----------------------------------|
|         |                                                                        |                    | 36kV                 |                                  |
|         |                                                                        | Yes/No             |                      |                                  |
| 37.     | Test Authority                                                         |                    |                      |                                  |
| 38.     | Test Certificate ref.                                                  |                    |                      |                                  |
| 39.     | Rated short time withstand current                                     | kA                 |                      |                                  |
| 40.     | Rated duration of short-circuit                                        | s                  |                      |                                  |
| 41.     | Rated peak withstand current                                           | kA                 |                      |                                  |
| 42.     | Rated insulation levels:-                                              |                    |                      |                                  |
| 43.     | Lightning impulse withstand to earth                                   | kV pk              |                      |                                  |
| 44.     | (wave shape 1.2/50µs)                                                  |                    |                      |                                  |
| 45.     | Lightning impulse withstand across open contacts (wave shape 1.2/50µs) | kV pk              |                      |                                  |
| 46.     | Power frequency voltage withstand to earth                             | kV rms             |                      |                                  |
| 47.     | Power frequency voltage withstand across open contacts                 | kV rms             |                      |                                  |
| 48.     | Switching impulse withstand to earth                                   | kV pk              |                      |                                  |
| 49.     | Switching impulse withstand across open contacts                       | kV pk              |                      |                                  |
| 50.     | Rated supply pressure of gas for interruption                          | MPa (g)            |                      |                                  |
| 51.     | Limits for correct operation<br>max<br>min                             | MPa (g)<br>MPa (g) |                      |                                  |
| 52.     | Frequency of operation                                                 | yr <sup>-1</sup>   |                      |                                  |
| 53.     | Operating mechanism Manufacturer                                       |                    |                      |                                  |
| 54.     | Mechanism Type:                                                        |                    |                      |                                  |
| 55.     | Trip free/or fixed trip                                                |                    |                      |                                  |
| 56.     | Is lockout facility fitted?                                            |                    |                      |                                  |
| 57.     | Closing supply<br>Volts<br>Amps<br>max/min                             | V<br>A             |                      |                                  |
| 58.     | Number of closing coils                                                | nos                |                      |                                  |

| Sl. No | Description                                                                                                                   | Unit            | Minimum Requirements | Guaranteed Technical particulars |
|--------|-------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------|----------------------------------|
|        |                                                                                                                               |                 | 36kV                 |                                  |
| 59.    | Number of opening coils                                                                                                       | nos             |                      |                                  |
| 60.    | Rated supply voltage of shunt opening release                                                                                 | V               |                      |                                  |
| 61.    | Current required at rated supply voltage to open circuit-breaker<br>Spring charging motor<br>- Current<br>- Voltage AC/DC     | A<br><br>A<br>V |                      |                                  |
| 62.    | Number of auxiliary switch contacts<br>- normally open<br>- normally closed<br>- adjustable                                   |                 |                      |                                  |
| 63.    | Other auxiliary loads:<br>Voltage:<br>Current:                                                                                |                 |                      |                                  |
| 64.    | Minimum creepage (25mm/KV)<br>(a) to earth<br>(b) across interrupter terminals                                                | mm<br>mm        |                      |                                  |
| 65.    | Radio interference voltage                                                                                                    | μV              |                      |                                  |
| 66.    | Guaranteed maximum gas leakage                                                                                                | % per annum     |                      |                                  |
| 67.    | Number of interrupters per pole                                                                                               |                 |                      |                                  |
| 68.    | Material of interrupter chamber                                                                                               |                 |                      |                                  |
| 69.    | Wall thickness of interrupter chamber                                                                                         | mm              |                      |                                  |
| 70.    | Material of contact surfaces primary arcing                                                                                   |                 |                      |                                  |
| 71.    | Length of each break                                                                                                          | mm              |                      |                                  |
| 72.    | Length of stroke                                                                                                              | mm              |                      |                                  |
| 73.    | Operating rod for moving contact(s) material<br><b>dimensions, etc.</b>                                                       |                 |                      |                                  |
| 74.    | Weight of circuit-breaker unit complete                                                                                       | kg              |                      |                                  |
| 75.    | Maximum shock load imposed on floor or foundations when opening under fault conditions (state whether tension or compression) | kg              |                      |                                  |
| 76.    | Quantity of gas in complete three-phase circuit breaker                                                                       |                 |                      |                                  |
| 77.    | Maximum pressure rise in circuit breakers due to the making or breaking of rated current                                      |                 |                      |                                  |

| Sl. No. | Description                                                  | Unit | Minimum Requirements | Guaranteed Technical particulars |
|---------|--------------------------------------------------------------|------|----------------------|----------------------------------|
|         |                                                              |      | 36kV                 |                                  |
| 78.     | Routine pressure test on circuit-breaker tanks or containers |      |                      |                                  |
| 79.     | Pressure type test on circuit-breaker tanks or containers    |      |                      |                                  |
| 80.     | Interrupting gas pressure at 20°C Normal                     |      |                      |                                  |
| 81.     | Limits of gas pressure at 20°C Maximum<br>Minimum            |      |                      |                                  |
| 82.     | Period of time equipment has been in commercial operation    |      |                      |                                  |
| 83.     | Number of the same type of circuit breakers supplied to date |      |                      |                                  |

## 1.2 DISCONNECTORS AND EARTHING SWITCHES

### 1.2.1 420KV DISCONNECTORS AND EARTHING SWITCHES

| Sl. No. | Description                                                                                              | Unit | Minimum Requirements                | Guaranteed Technical particulars |
|---------|----------------------------------------------------------------------------------------------------------|------|-------------------------------------|----------------------------------|
|         |                                                                                                          |      | 420kV                               |                                  |
| 1.      | Manufacturer & country of origin                                                                         |      |                                     |                                  |
| 2.      | Model Reference (Manufacturer's designation)                                                             |      |                                     |                                  |
| 3.      | Type                                                                                                     |      | Outdoor,<br>Horizontal double break |                                  |
| 4.      | Standard                                                                                                 |      | IEC 62271-102                       |                                  |
| 5.      | Rated voltage                                                                                            |      | 420 kV                              |                                  |
| 6.      | Rated short-duration power frequency withstand voltage (1 min.)<br>To earth<br>Across isolating distance |      | 520 kV rms<br>610 kV rms            |                                  |
| 7.      | Rated switching impulse withstand voltage<br>To earth<br>Across isolating distance                       |      | 1050 kV peak<br>900 (+345) kV peak  |                                  |
| 8.      | Rated lightning impulse withstand voltage<br>- To earth<br>Across isolating distance                     |      | 1425 kV peak<br>1425 (+240) kV peak |                                  |
| 9.      | Corona extinction voltage                                                                                |      | 320 kV rms                          |                                  |
| 10.     | Rated short circuit current (I <sub>th</sub> ), 1s                                                       |      | 63 kA rms                           |                                  |
| 11.     | Rated short circuit current (I <sub>dyn</sub> )                                                          |      | 158 kA peak                         |                                  |
| 12.     | Operating mechanism of isolator / earthing switch                                                        |      | AC motor operated                   |                                  |
| 13.     | Number of auxiliary contacts for main switch<br>- Making<br>- Breaking<br>Middle position                |      | Min. 12<br>Min. 12<br>Min. 1        |                                  |

| Sl. No. | Description                                                                                   | Unit                             | Minimum Requirements            | Guaranteed Technical particulars |
|---------|-----------------------------------------------------------------------------------------------|----------------------------------|---------------------------------|----------------------------------|
|         |                                                                                               |                                  | 420kV                           |                                  |
| 14.     | Number of auxiliary contacts for earthing switch<br>- Making<br>- Breaking<br>Middle position |                                  | Min. 12<br>Min. 12<br>Min. 1    |                                  |
| 15.     | Radio interference level for 0.5 MHz to 2 MHz                                                 |                                  | 1000 micro V<br>(at 266 kV rms) |                                  |
| 16.     | Type Number                                                                                   |                                  |                                 |                                  |
| 17.     | Operating type                                                                                |                                  |                                 |                                  |
| 18.     | (a) horizontal/vertical break                                                                 |                                  |                                 |                                  |
| 19.     | (b) Pantograph                                                                                |                                  |                                 |                                  |
| 20.     | (c) Number of support insulation for pole                                                     |                                  |                                 |                                  |
| 21.     | (d) Number of breaks per pole                                                                 |                                  |                                 |                                  |
| 22.     | (e) Material of contact surfaces                                                              |                                  |                                 |                                  |
| 23.     | (f) Type of Contacts                                                                          |                                  |                                 |                                  |
| 24.     | Rated normal current                                                                          | A                                |                                 |                                  |
| 25.     | Rated short time withstand current                                                            | kA, rms                          |                                 |                                  |
| 26.     | Rated duration of short time current                                                          | s                                |                                 |                                  |
| 27.     | Rated peak withstand current                                                                  | kA pk                            |                                 |                                  |
| 28.     | Rated insulation levels:                                                                      |                                  |                                 |                                  |
| 29.     | Lightning impulse withstand to earth (waveshape: 1.2/50µs)                                    | kV pk                            |                                 |                                  |
| 30.     | Lightning impulse withstand across open contacts (waveshape: 1.2/50µs)                        | kV pk                            |                                 |                                  |
| 31.     | Power frequency voltage withstand to earth                                                    | kV rms                           |                                 |                                  |
| 32.     | Power frequency voltage withstand across open contacts                                        | kV rms                           |                                 |                                  |
| 33.     | Contact Resistance                                                                            |                                  |                                 |                                  |
| 34.     | Method of operation                                                                           |                                  |                                 |                                  |
| 35.     | Type of operating mechanism manual/power                                                      |                                  |                                 |                                  |
| 36.     | Operating power                                                                               |                                  |                                 |                                  |
| 37.     | Voltage/pressure rated<br>max<br>min                                                          | V/MPa(g)<br>V/MPa(g)<br>V/MPa(g) |                                 |                                  |
| 38.     | Auxiliary Consumption                                                                         | A                                |                                 |                                  |

| Sl. No. | Description                                                                          | Unit     | Minimum Requirements | Guaranteed Technical particulars |
|---------|--------------------------------------------------------------------------------------|----------|----------------------|----------------------------------|
|         |                                                                                      |          | 420kV                |                                  |
| 39.     | Operating time: open max<br>min                                                      | ms<br>ms |                      |                                  |
| 40.     | Operating time: close max<br>min                                                     | ms<br>ms |                      |                                  |
| 41.     | Manual operating torque                                                              | kNm      |                      |                                  |
| 42.     | Load switching capability<br>Inductive<br>Capacitive                                 | A        |                      |                                  |
| 43.     | Mechanical Terminal Load                                                             | N        |                      |                                  |
| 44.     | Insulator Creepage ( 25mm/kV)                                                        | mm       |                      |                                  |
| 45.     | Radio interference voltage                                                           | mV       |                      |                                  |
| 46.     | Number of auxiliary switches<br>- normally open<br>- normally closed<br>- adjustable |          |                      |                                  |
| 47.     | Other auxiliary loads<br>- voltage<br>- current                                      |          |                      |                                  |
| 48.     | Mechanical endurance:                                                                |          |                      |                                  |
| 49.     | Number of operations carried out for mechanical operation test                       |          |                      |                                  |
| 50.     | Degree of protection for<br>1) auxiliary circuits<br>2) moving parts                 |          |                      |                                  |
| 51.     | Total weight of three pole disconnector complete                                     | kg       |                      |                                  |
| 52.     | Type test certificate date/reference                                                 |          |                      |                                  |
| 53.     | Period of time equipment has been in commercial operation                            |          |                      |                                  |
| 54.     | Number of the same type of disconnectors supplied to date                            |          |                      |                                  |

### 1.2.2 230KV DISCONNECTORS AND EARTHING SWITCHES

| Sl. No. | Description                                  | Unit | Miniumim Requirements | Guaranteed Technical Particulars |
|---------|----------------------------------------------|------|-----------------------|----------------------------------|
|         |                                              |      | 245KV                 |                                  |
| 1.      | Manufacturer & country of origin             |      |                       |                                  |
| 2.      | Model Reference (Manufacturer's designation) |      |                       |                                  |
| 3.      | Type                                         |      | Outdoor,              |                                  |

| Sl. No. | Description                                                                                              | Unit    | Miniumim Requirements        | Guranteed Technical Particulars |
|---------|----------------------------------------------------------------------------------------------------------|---------|------------------------------|---------------------------------|
|         |                                                                                                          |         | 245KV                        |                                 |
|         |                                                                                                          |         | Double side break            |                                 |
| 4.      | Standard                                                                                                 |         | IEC 62271-102                |                                 |
| 5.      | Rated voltage                                                                                            |         | 245 kV                       |                                 |
| 6.      | Rated short-duration power frequency withstand voltage (1 min.)<br>To earth<br>Across isolating distance |         | 460 kV rms<br>530 kV rms     |                                 |
| 7.      | Rated switching impulse withstand voltage<br>To earth<br>Across isolating distance                       |         |                              |                                 |
| 8.      | Rated lightning impulse withstand voltage<br>- To earth<br>Across isolating distance                     |         | 1050 kV peak<br>1200 kV peak |                                 |
| 9.      | Corona extinction voltage                                                                                |         |                              |                                 |
| 10.     | Rated short circuit current (Ith), 1s                                                                    |         | 50 kA rms                    |                                 |
| 11.     | Rated short circuit current (Idyn)                                                                       |         | 125 kA peak                  |                                 |
| 12.     | Operating mechanism of isolator / earthing switch                                                        |         | AC motor operated            |                                 |
| 13.     | Number of auxiliary contacts for main switch<br>- Making<br>- Breaking<br>Middle position                |         | Min. 12<br>Min. 12<br>Min. 1 |                                 |
| 14.     | Number of auxiliary contacts for earthing switch<br>- Making<br>- Breaking<br>Middle position            |         | Min. 10<br>Min. 10<br>Min. 1 |                                 |
| 15.     | Radio interference level for 0.5 MHz to 2 MHz                                                            |         | 500 micro V (at 92 kV rms)   |                                 |
| 16.     | Type Number                                                                                              |         |                              |                                 |
| 17.     | Operating type                                                                                           |         |                              |                                 |
| 18.     | (a) horizontal/vertical break                                                                            |         |                              |                                 |
| 19.     | (b) Pantograph                                                                                           |         |                              |                                 |
| 20.     | (c) Number of support insulation for pole                                                                |         |                              |                                 |
| 21.     | (d) Number of breaks per pole                                                                            |         |                              |                                 |
| 22.     | (e) Material of contact surfaces                                                                         |         |                              |                                 |
| 23.     | (f) Type of Contacts                                                                                     |         |                              |                                 |
| 24.     | Rated normal current                                                                                     | A       |                              |                                 |
| 25.     | Rated short time withstand current                                                                       | kA, rms |                              |                                 |
| 26.     | Rated duration of short time current                                                                     | s       |                              |                                 |
| 27.     | Rated peak withstand current                                                                             | kA pk   |                              |                                 |
| 28.     | Rated insulation levels:                                                                                 |         |                              |                                 |

| Sl. No. | Description                                                                          | Unit                             | Miniumim Requirements | Guranteed Technical Particulars |
|---------|--------------------------------------------------------------------------------------|----------------------------------|-----------------------|---------------------------------|
|         |                                                                                      |                                  | 245KV                 |                                 |
| 29.     | Lightning impulse withstand to earth (waveshape: 1.2/50µs)                           | kV pk                            |                       |                                 |
| 30.     | Lightning impulse withstand across open contacts (waveshape: 1.2/50µs)               | kV pk                            |                       |                                 |
| 31.     | Power frequency voltage withstand to earth                                           | kV rms                           |                       |                                 |
| 32.     | Power frequency voltage withstand across open contacts                               | kV rms                           |                       |                                 |
| 33.     | Contact Resistance                                                                   |                                  |                       |                                 |
| 34.     | Method of operation                                                                  |                                  |                       |                                 |
| 35.     | Type of operating mechanism manual/power                                             |                                  |                       |                                 |
| 36.     | Operating power                                                                      |                                  |                       |                                 |
| 37.     | Voltage/pressure rated<br>max<br>min                                                 | V/MPa(g)<br>V/MPa(g)<br>V/MPa(g) |                       |                                 |
| 38.     | Auxiliary Consumption                                                                | A                                |                       |                                 |
| 39.     | Operating time: open max<br>min                                                      | ms<br>ms                         |                       |                                 |
| 40.     | Operating time: close max<br>min                                                     | ms<br>ms                         |                       |                                 |
| 41.     | Manual operating torque                                                              | kNm                              |                       |                                 |
| 42.     | Load switching capability<br>Inductive<br>Capacitive                                 | A                                |                       |                                 |
| 43.     | Mechanical Terminal Load                                                             | N                                |                       |                                 |
| 44.     | Insulator Creepage ( 25mm/kV)                                                        | mm                               |                       |                                 |
| 45.     | Radio interference voltage                                                           | mV                               |                       |                                 |
| 46.     | Number of auxiliary switches<br>- normally open<br>- normally closed<br>- adjustable |                                  |                       |                                 |
| 47.     | Other auxiliary loads<br>- voltage<br>- current                                      |                                  |                       |                                 |
| 48.     | Mechanical endurance:                                                                |                                  |                       |                                 |
| 49.     | Number of operations carried out for mechanical operation test                       |                                  |                       |                                 |
| 50.     | Degree of protection for<br>1) auxiliary circuits<br>2) moving parts                 |                                  |                       |                                 |

| Sl. No. | Description                                               | Unit | Miniumim Requirements | Guranteed Technical Particulars |
|---------|-----------------------------------------------------------|------|-----------------------|---------------------------------|
|         |                                                           |      | 245KV                 |                                 |
| 51.     | Total weight of three pole disconnector complete          | kg   |                       |                                 |
| 52.     | Type test certificate date/reference                      |      |                       |                                 |
| 53.     | Period of time equipment has been in commercial operation |      |                       |                                 |
| 54.     | Number of the same type of disconnectors supplied to date |      |                       |                                 |

### 1.2.3 145KV DISCONNECTORS AND EARTHING SWITCHES

| Sl. No. | Description                                                                                              | Unit | Miniumim Requirements         | Guranteed Technical Particulars |
|---------|----------------------------------------------------------------------------------------------------------|------|-------------------------------|---------------------------------|
|         |                                                                                                          |      | 145kV                         |                                 |
| 1.      | Manufacturer & country of origin                                                                         |      |                               |                                 |
| 2.      | Model Reference (Manufacturer's designation)                                                             |      |                               |                                 |
| 3.      | Type                                                                                                     |      | Outdoor,<br>Double side break |                                 |
| 4.      | Standard                                                                                                 |      | IEC 62271-102                 |                                 |
| 5.      | Rated voltage                                                                                            |      | 145 kV                        |                                 |
| 6.      | Rated short-duration power frequency withstand voltage (1 min.)<br>To earth<br>Across isolating distance |      | 275 kV rms<br>315 kV rms      |                                 |
| 7.      | Rated switching impulse withstand voltage<br>To earth<br>Across isolating distance                       |      |                               |                                 |
| 8.      | Rated lightning impulse withstand voltage<br>- To earth<br>Across isolating distance                     |      | 650 kV peak<br>750 kV peak    |                                 |
| 9.      | Corona extinction voltage                                                                                |      |                               |                                 |
| 10.     | Rated short circuit current (Ith), 1s                                                                    |      | 40 kA rms                     |                                 |
| 11.     | Rated short circuit current (Idyn)                                                                       |      | 100 kA peak                   |                                 |
| 12.     | Operating mechanism of isolator / earthing switch                                                        |      | AC motor operated             |                                 |
| 13.     | Number of auxiliary contacts for main switch<br>- Making<br>- Breaking<br>Middle position                |      | Min. 12<br>Min. 12<br>Min. 1  |                                 |
| 14.     | Number of auxiliary contacts for earthing switch<br>- Making<br>- Breaking<br>Middle position            |      | Min. 10<br>Min. 10<br>Min. 1  |                                 |

| Sl. No. | Description                                                                  | Unit                             | Miniumim Requirements      | Guranteed Technical Particulars |
|---------|------------------------------------------------------------------------------|----------------------------------|----------------------------|---------------------------------|
|         |                                                                              |                                  | 145kV                      |                                 |
| 15.     | Radio interference level for 0.5 MHz to 2 MHz                                |                                  | 500 micro V (at 92 kV rms) |                                 |
| 16.     | Type Number                                                                  |                                  |                            |                                 |
| 17.     | Operating type                                                               |                                  |                            |                                 |
| 18.     | (a) horizontal/vertical break                                                |                                  |                            |                                 |
| 19.     | (b) Pantograph                                                               |                                  |                            |                                 |
| 20.     | (c) Number of support insulation for pole                                    |                                  |                            |                                 |
| 21.     | (d) Number of breaks per pole                                                |                                  |                            |                                 |
| 22.     | (e) Material of contact surfaces                                             |                                  |                            |                                 |
| 23.     | (f) Type of Contacts                                                         |                                  |                            |                                 |
| 24.     | Rated normal current                                                         | A                                |                            |                                 |
| 25.     | Rated short time withstand current                                           | kA, rms                          |                            |                                 |
| 26.     | Rated duration of short time current                                         | s                                |                            |                                 |
| 27.     | Rated peak withstand current                                                 | kA pk                            |                            |                                 |
| 28.     | Rated insulation levels:                                                     |                                  |                            |                                 |
| 29.     | Lightning impulse withstand to earth (waveshape: 1.2/50 $\mu$ s)             | kV pk                            |                            |                                 |
| 30.     | Lightning impulse withstand across open contacts (waveshape: 1.2/50 $\mu$ s) | kV pk                            |                            |                                 |
| 31.     | Power frequency voltage withstand to earth                                   | kV rms                           |                            |                                 |
| 32.     | Power frequency voltage withstand across open contacts                       | kV rms                           |                            |                                 |
| 33.     | Contact Resistance                                                           |                                  |                            |                                 |
| 34.     | Method of operation                                                          |                                  |                            |                                 |
| 35.     | Type of operating mechanism manual/power                                     |                                  |                            |                                 |
| 36.     | Operating power                                                              |                                  |                            |                                 |
| 37.     | Voltage/pressure rated<br>max<br>min                                         | V/MPa(g)<br>V/MPa(g)<br>V/MPa(g) |                            |                                 |
| 38.     | Auxiliary Consumption                                                        | A                                |                            |                                 |
| 39.     | Operating time: open max<br>min                                              | ms<br>ms                         |                            |                                 |
| 40.     | Operating time: close max<br>min                                             | ms<br>ms                         |                            |                                 |
| 41.     | Manual operating torque                                                      | kNm                              |                            |                                 |

| Sl. No. | Description                                                                          | Unit | Miniumim Requirements | Guranteed Technical Particulars |
|---------|--------------------------------------------------------------------------------------|------|-----------------------|---------------------------------|
|         |                                                                                      |      | 145kV                 |                                 |
| 42.     | Load switching capability<br>Inductive<br>Capacitive                                 | A    |                       |                                 |
| 43.     | Mechanical Terminal Load                                                             | N    |                       |                                 |
| 44.     | Insulator Creepage ( 25mm/kV)                                                        | mm   |                       |                                 |
| 45.     | Radio interference voltage                                                           | mV   |                       |                                 |
| 46.     | Number of auxiliary switches<br>- normally open<br>- normally closed<br>- adjustable |      |                       |                                 |
| 47.     | Other auxiliary loads<br>- voltage<br>- current                                      |      |                       |                                 |
| 48.     | Mechanical endurance:                                                                |      |                       |                                 |
| 49.     | Number of operations carried out for mechanical operation test                       |      |                       |                                 |
| 50.     | Degree of protection for<br>1) auxiliary circuits<br>2) moving parts                 |      |                       |                                 |
| 51.     | Total weight of three pole disconnector complete                                     | kg   |                       |                                 |
| 52.     | Type test certificate date/reference                                                 |      |                       |                                 |
| 53.     | Period of time equipment has been in commercial operation                            |      |                       |                                 |
| 54.     | Number of the same type of disconnectors supplied to date                            |      |                       |                                 |

#### 1.2.4 33KV DISCONNECTORS AND EARTHING SWITCHES

| Sl. No. | Description                                                     | Unit | Miniumim Requirements             | Guranteed Technical Particulars |
|---------|-----------------------------------------------------------------|------|-----------------------------------|---------------------------------|
|         |                                                                 |      | 36kV                              |                                 |
| 1.      | Manufacturer & country of origin                                |      |                                   |                                 |
| 2.      | Model Reference (Manufacturer's designation)                    |      |                                   |                                 |
| 3.      | Type                                                            |      | Outdoor,<br>Single vertical break |                                 |
| 4.      | Standard                                                        |      | IEC 62271-102                     |                                 |
| 5.      | Rated voltage                                                   |      | 36 kV                             |                                 |
| 6.      | Rated short-duration power frequency withstand voltage (1 min.) |      | 70 kV rms                         |                                 |

| Sl. No. | Description                                                                                   | Unit    | Miniumim Requirements      | Guranteed Technical Particulars |
|---------|-----------------------------------------------------------------------------------------------|---------|----------------------------|---------------------------------|
|         |                                                                                               |         | 36kV                       |                                 |
|         | To earth<br>Across isolating distance                                                         |         |                            |                                 |
| 7.      | Rated switching impulse withstand voltage<br>To earth<br>Across isolating distance            |         |                            |                                 |
| 8.      | Rated lightning impulse withstand voltage<br>- To earth<br>Across isolating distance          |         | 170 kV peak                |                                 |
| 9.      | Corona extinction voltage                                                                     |         |                            |                                 |
| 10.     | Rated short circuit current (Ith), 1s                                                         |         | 31.5 kA rms                |                                 |
| 11.     | Rated short circuit current (Idyn)                                                            |         | 78.75 kA peak              |                                 |
| 12.     | Operating mechanism of isolator / earthing switch                                             |         | AC motor operated          |                                 |
| 13.     | Number of auxiliary contacts for main switch<br>- Making<br>- Breaking<br>Middle position     |         | Min. 6<br>Min. 6<br>Min. 1 |                                 |
| 14.     | Number of auxiliary contacts for earthing switch<br>- Making<br>- Breaking<br>Middle position |         |                            |                                 |
| 15.     | Radio interference level for 0.5 MHz to 2 MHz                                                 |         |                            |                                 |
| 16.     | Type Number                                                                                   |         |                            |                                 |
| 17.     | Operating type                                                                                |         |                            |                                 |
| 18.     | (a) horizontal/vertical break                                                                 |         |                            |                                 |
| 19.     | (b) Pantograph                                                                                |         |                            |                                 |
| 20.     | (c) Number of support insulation for pole                                                     |         |                            |                                 |
| 21.     | (d) Number of breaks per pole                                                                 |         |                            |                                 |
| 22.     | (e) Material of contact surfaces                                                              |         |                            |                                 |
| 23.     | (f) Type of Contacts                                                                          |         |                            |                                 |
| 24.     | Rated normal current                                                                          | A       |                            |                                 |
| 25.     | Rated short time withstand current                                                            | kA, rms |                            |                                 |
| 26.     | Rated duration of short time current                                                          | s       |                            |                                 |
| 27.     | Rated peak withstand current                                                                  | kA pk   |                            |                                 |
| 28.     | Rated insulation levels:                                                                      |         |                            |                                 |
| 29.     | Lightning impulse withstand to earth (waveshape: 1.2/50µs)                                    | kV pk   |                            |                                 |
| 30.     | Lightning impulse withstand across open contacts (waveshape: 1.2/50µs)                        | kV pk   |                            |                                 |

| Sl. No. | Description                                                                          | Unit                             | Miniumim Requirements | Guranteed Technical Particulars |
|---------|--------------------------------------------------------------------------------------|----------------------------------|-----------------------|---------------------------------|
|         |                                                                                      |                                  | 36kV                  |                                 |
| 31.     | Power frequency voltage withstand to earth                                           | kV rms                           |                       |                                 |
| 32.     | Power frequency voltage withstand across open contacts                               | kV rms                           |                       |                                 |
| 33.     | Contact Resistance                                                                   |                                  |                       |                                 |
| 34.     | Method of operation                                                                  |                                  |                       |                                 |
| 35.     | Type of operating mechanism manual/power                                             |                                  |                       |                                 |
| 36.     | Operating power                                                                      |                                  |                       |                                 |
| 37.     | Voltage/pressure rated<br>max<br>min                                                 | V/MPa(g)<br>V/MPa(g)<br>V/MPa(g) |                       |                                 |
| 38.     | Auxiliary Consumption                                                                | A                                |                       |                                 |
| 39.     | Operating time: open max<br>min                                                      | ms<br>ms                         |                       |                                 |
| 40.     | Operating time: close max<br>min                                                     | ms<br>ms                         |                       |                                 |
| 41.     | Manual operating torque                                                              | kNm                              |                       |                                 |
| 42.     | Load switching capability<br>Inductive<br>Capacitive                                 | A                                |                       |                                 |
| 43.     | Mechanical Terminal Load                                                             | N                                |                       |                                 |
| 44.     | Insulator Creepage ( 25mm/kV)                                                        | mm                               |                       |                                 |
| 45.     | Radio interference voltage                                                           | mV                               |                       |                                 |
| 46.     | Number of auxiliary switches<br>- normally open<br>- normally closed<br>- adjustable |                                  |                       |                                 |
| 47.     | Other auxiliary loads<br>- voltage<br>- current                                      |                                  |                       |                                 |
| 48.     | Mechanical endurance:                                                                |                                  |                       |                                 |
| 49.     | Number of operations carried out for mechanical operation test                       |                                  |                       |                                 |
| 50.     | Degree of protection for<br>1) auxiliary circuits<br>2) moving parts                 |                                  |                       |                                 |
| 51.     | Total weight of three pole disconnector complete                                     | kg                               |                       |                                 |
| 52.     | Type test certificate date/reference                                                 |                                  |                       |                                 |

| Sl. No. | Description                                               | Unit | Miniumim Requirements | Guranteed Technical Particulars |
|---------|-----------------------------------------------------------|------|-----------------------|---------------------------------|
|         |                                                           |      | 36kV                  |                                 |
| 53.     | Period of time equipment has been in commercial operation |      |                       |                                 |
| 54.     | Number of the same type of disconnectors supplied to date |      |                       |                                 |

### 1.3 CURRENT TRANSFORMERS

#### 1.3.1 420KV CURRENT TRANSFORMER

| Sl. No. | Description                                                                        | Unit             | Minimum Requirements        | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------------------------|------------------|-----------------------------|----------------------------------|
|         |                                                                                    |                  | 420kV                       |                                  |
| 1.      | Manufacturer & country of origin                                                   |                  |                             |                                  |
| 2.      | Model Reference (Manufacturer's designation)                                       |                  |                             |                                  |
| 3.      | Rated lightning impulse withstand voltage                                          |                  | 1425 kVp                    |                                  |
| 4.      | Rated switching impulse withstand voltage                                          |                  | 1050 kVp                    |                                  |
| 5.      | Power frequency withstand voltage (1 min.)                                         |                  | 630 kVrms                   |                                  |
| 6.      | Corona extinction voltage                                                          |                  | 320 kVrms                   |                                  |
| 7.      | Radio interference level for 0.5 MHz to 2 MHz                                      |                  | 1000 micro V (at 266 kVrms) |                                  |
| 8.      | Partial discharge level                                                            |                  | 10 pC                       |                                  |
| 9.      | Type of insulation                                                                 |                  | Class A                     |                                  |
| 10.     | Rated primary current                                                              | A rms            |                             |                                  |
| 11.     | Rated secondary current                                                            | A rms            |                             |                                  |
| 12.     | Rated frequency                                                                    | Hz               |                             |                                  |
| 13.     | Highest voltage for equipment                                                      | kV               |                             |                                  |
| 14.     | Rated insulation level - primary winding                                           | kV               |                             |                                  |
| 15.     | Lightning impulse withstand                                                        | kV pk            |                             |                                  |
| 16.     | (a) Power frequency withstand (dry)<br>(b) Power frequency withstand (wet)         | kV rms<br>kV rms |                             |                                  |
| 17.     | Insulator creepage (phase to earth)                                                | mm               |                             |                                  |
| 18.     | Electrical dissipation factor at power frequency test voltage                      |                  |                             |                                  |
| 19.     | Radio influence voltage measured at $U/\sqrt{3}$ 1 MHz                             | $\mu V$          |                             |                                  |
| 20.     | Rated short term thermal current for 1s<br>Rated short term thermal current for 3s | A rms<br>A rms   |                             |                                  |
| 21.     | Rated dynamic current                                                              | kA pk            |                             |                                  |
| 22.     | Insulation class                                                                   |                  |                             |                                  |
| 23.     | Number of secondary windings                                                       |                  |                             |                                  |

|     |                                                                                                                                                         |        |  |  |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--|--|
| 24. | Location of core                                                                                                                                        |        |  |  |
| 25. | Core 1 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 26. | Core 2 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 27. | Core 3 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 28. | Core 4 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 29. | Class X winding:<br>- Rated knee point emf<br>- Exciting current<br>- Resistance <sup>a</sup><br>*including instrument security factor where applicable | V<br>A |  |  |
| 30. | Is earth screen fitted between primary and secondary windings                                                                                           |        |  |  |
| 31. | Maximum cantilever strength                                                                                                                             | Nm     |  |  |
| 32. | Type test certificate ref/date                                                                                                                          |        |  |  |

- a. Preliminary value. Actual shall be as per Detail Engineering during execution

### 1.3.2 230KV CURRENT TRANSFORMER

| Sl. No. | Description                                                                        | Unit             | Minimum Requirements           | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------------------------|------------------|--------------------------------|----------------------------------|
|         |                                                                                    |                  | 245KV                          |                                  |
| 1.      | Manufacturer & country of origin                                                   |                  |                                |                                  |
| 2.      | Model Reference (Manufacturer's designation)                                       |                  |                                |                                  |
| 3.      | Rated lightning impulse withstand voltage                                          |                  | 1050kVp                        |                                  |
| 4.      | Rated switching impulse withstand voltage                                          |                  | -                              |                                  |
| 5.      | Power frequency withstand voltage (1 min.)                                         |                  | 460kVrms                       |                                  |
| 6.      | Corona extinction voltage                                                          |                  | 156KV                          |                                  |
| 7.      | Radio interference level for 0.5 MHz to 2 MHz                                      |                  | 1000 micro V<br>(at 156 kVrms) |                                  |
| 8.      | Partial discharge level                                                            |                  | 10 pC                          |                                  |
| 9.      | Type of insulation                                                                 |                  | Class A                        |                                  |
| 10.     | Rated primary current                                                              | A rms            |                                |                                  |
| 11.     | Rated secondary current                                                            | A rms            |                                |                                  |
| 12.     | Rated frequency                                                                    | Hz               |                                |                                  |
| 13.     | Highest voltage for equipment                                                      | kV               |                                |                                  |
| 14.     | Rated insulation level - primary winding                                           | kV               |                                |                                  |
| 15.     | Lightning impulse withstand                                                        | kV pk            |                                |                                  |
| 16.     | (a) Power frequency withstand (dry)<br>(b) Power frequency withstand (wet)         | kV rms<br>kV rms |                                |                                  |
| 17.     | Insulator creepage (phase to earth)                                                | mm               |                                |                                  |
| 18.     | Electrical dissipation factor at power frequency test voltage                      |                  |                                |                                  |
| 19.     | Radio influence voltage measured at $U/\sqrt{3}$ 1 MHz                             | $\mu V$          |                                |                                  |
| 20.     | Rated short term thermal current for 1s<br>Rated short term thermal current for 3s | A rms<br>A rms   |                                |                                  |
| 21.     | Rated dynamic current                                                              | kA pk            |                                |                                  |
| 22.     | Insulation class                                                                   |                  |                                |                                  |
| 23.     | Number of secondary windings                                                       |                  |                                |                                  |
| 24.     | Location of core                                                                   |                  |                                |                                  |

|     |                                                                                                                                                         |        |  |  |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--|--|
| 25. | Core 1 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 26. | Core 2 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 27. | Core 3 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 28. | Core 4 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 29. | Class X winding:<br>- Rated knee point emf<br>- Exciting current<br>- Resistance <sup>a</sup><br>*including instrument security factor where applicable | V<br>A |  |  |
| 30. | Is earth screen fitted between primary and secondary windings                                                                                           |        |  |  |
| 31. | Maximum cantilever strength                                                                                                                             | Nm     |  |  |
| 32. | Type test certificate ref/date                                                                                                                          |        |  |  |

### 1.3.3 145KV CURRENT TRANSFORMER

| Sl. No. | Description                                   | Unit  | Minimum Requirements         | Guaranteed Technical Particulars |
|---------|-----------------------------------------------|-------|------------------------------|----------------------------------|
|         |                                               |       | 145kV                        |                                  |
| 1.      | Manufacturer & country of origin              |       |                              |                                  |
| 2.      | Model Reference (Manufacturer's designation)  |       |                              |                                  |
| 3.      | Rated lightning impulse withstand voltage     |       | 650kVp                       |                                  |
| 4.      | Rated switching impulse withstand voltage     |       | -                            |                                  |
| 5.      | Power frequency withstand voltage (1 min.)    |       | 275kVrms                     |                                  |
| 6.      | Corona extinction voltage                     |       | -                            |                                  |
| 7.      | Radio interference level for 0.5 MHz to 2 MHz |       | 500 micro V<br>(at 92 kVrms) |                                  |
| 8.      | Partial discharge level                       |       | 10 pC                        |                                  |
| 9.      | Type of insulation                            |       | Class A                      |                                  |
| 10.     | Rated primary current                         | A rms |                              |                                  |
| 11.     | Rated secondary current                       | A rms |                              |                                  |

|     |                                                                                                                                                         |                  |  |  |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--|--|
| 12. | Rated frequency                                                                                                                                         | Hz               |  |  |
| 13. | Highest voltage for equipment                                                                                                                           | kV               |  |  |
| 14. | Rated insulation level - primary winding                                                                                                                | kV               |  |  |
| 15. | Lightning impulse withstand                                                                                                                             | kV pk            |  |  |
| 16. | (a) Power frequency withstand (dry)<br>(b) Power frequency withstand (wet)                                                                              | kV rms<br>kV rms |  |  |
| 17. | Insulator creepage (phase to earth)                                                                                                                     | mm               |  |  |
| 18. | Electrical dissipation factor at power frequency test voltage                                                                                           |                  |  |  |
| 19. | Radio influence voltage measured at $U/\sqrt{3}$ 1 MHz                                                                                                  | $\mu V$          |  |  |
| 20. | Rated short term thermal current for 1s<br>Rated short term thermal current for 3s                                                                      | A rms<br>A rms   |  |  |
| 21. | Rated dynamic current                                                                                                                                   | kA pk            |  |  |
| 22. | Insulation class                                                                                                                                        |                  |  |  |
| 23. | Number of secondary windings                                                                                                                            |                  |  |  |
| 24. | Location of core                                                                                                                                        |                  |  |  |
| 25. | Core 1 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |                  |  |  |
| 26. | Core 2 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |                  |  |  |
| 27. | Core 3 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |                  |  |  |
| 28. | Core 4 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |                  |  |  |
| 29. | Class X winding:<br>- Rated knee point emf<br>- Exciting current<br>- Resistance <sup>a</sup><br>*including instrument security factor where applicable | V<br>A           |  |  |
| 30. | Is earth screen fitted between primary and secondary windings                                                                                           |                  |  |  |

|     |                                |    |  |  |
|-----|--------------------------------|----|--|--|
| 31. | Maximum cantilever strength    | Nm |  |  |
| 32. | Type test certificate ref/date |    |  |  |

### 1.3.1 36KV CURRENT TRANSFORMER

| Sl. No. | Description                                                                        | Unit             | Minimum Requirements | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------------------------|------------------|----------------------|----------------------------------|
|         |                                                                                    |                  | 36kV                 |                                  |
| 33.     | Manufacturer & country of origin                                                   |                  |                      |                                  |
| 34.     | Model Reference (Manufacturer's designation)                                       |                  |                      |                                  |
| 35.     | Rated lightning impulse withstand voltage                                          |                  | 170KVp               |                                  |
| 36.     | Rated switching impulse withstand voltage                                          |                  |                      |                                  |
| 37.     | Power frequency withstand voltage (1 min.)                                         |                  | 70KVp                |                                  |
| 38.     | Corona extinction voltage                                                          |                  |                      |                                  |
| 39.     | Radio interference level for 0.5 MHz to 2 MHz                                      |                  |                      |                                  |
| 40.     | Partial discharge level                                                            |                  | 10 pC                |                                  |
| 41.     | Type of insulation                                                                 |                  | Class A              |                                  |
| 42.     | Rated primary current                                                              | A rms            |                      |                                  |
| 43.     | Rated secondary current                                                            | A rms            |                      |                                  |
| 44.     | Rated frequency                                                                    | Hz               |                      |                                  |
| 45.     | Highest voltage for equipment                                                      | kV               |                      |                                  |
| 46.     | Rated insulation level - primary winding                                           | kV               |                      |                                  |
| 47.     | Lightning impulse withstand                                                        | kV pk            |                      |                                  |
| 48.     | (a) Power frequency withstand (dry)<br>(b) Power frequency withstand (wet)         | kV rms<br>kV rms |                      |                                  |
| 49.     | Insulator creepage (phase to earth)                                                | mm               |                      |                                  |
| 50.     | Electrical dissipation factor at power frequency test voltage                      |                  |                      |                                  |
| 51.     | Radio influence voltage measured at $U/\sqrt{3}$ 1 MHz                             | $\mu V$          |                      |                                  |
| 52.     | Rated short term thermal current for 1s<br>Rated short term thermal current for 3s | A rms<br>A rms   |                      |                                  |
| 53.     | Rated dynamic current                                                              | kA pk            |                      |                                  |
| 54.     | Insulation class                                                                   |                  |                      |                                  |
| 55.     | Number of secondary windings                                                       |                  |                      |                                  |
| 56.     | Location of core                                                                   |                  |                      |                                  |

|     |                                                                                                                                                         |        |  |  |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--|--|
| 57. | Core 1 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 58. | Core 2 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 59. | Core 3 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 60. | Core 4 Rated output<br>Accuracy class *<br>Accuracy limit factor<br>burden<br>Resistance <sup>a</sup>                                                   |        |  |  |
| 61. | Class X winding:<br>- Rated knee point emf<br>- Exciting current<br>- Resistance <sup>a</sup><br>*including instrument security factor where applicable | V<br>A |  |  |
| 62. | Is earth screen fitted between primary and secondary windings                                                                                           |        |  |  |
| 63. | Maximum cantilever strength                                                                                                                             | Nm     |  |  |
| 64. | Type test certificate ref/date                                                                                                                          |        |  |  |

## 1.4 CAPACITIVE VOLTAGE TRANSFORMERS

### 1.4.1 420KV CAPACITIVE VOLTAGE TRANSFORMERS

| Sl. No. | Description                                                      | Unit   | Minimum Requirements | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------|--------|----------------------|----------------------------------|
|         |                                                                  |        | 420kV                |                                  |
| 1.      | Manufacturer & country of origin                                 |        |                      |                                  |
| 2.      | Model Reference (Manufacturer's designation)                     |        |                      |                                  |
| 3.      | Type No.                                                         | -      |                      |                                  |
| 4.      | Transformer type                                                 | -      |                      |                                  |
| 5.      | Rated primary voltage                                            | kV rms | 420 kV               |                                  |
| 6.      | Rated Impedance                                                  |        |                      |                                  |
| 7.      | Rated secondary voltage for each secondary winding               | kV rms |                      |                                  |
| 8.      | Accuracy class for each winding<br>Rated output for each winding | VA     |                      |                                  |

|     |                                                                                                  |                  |                                                        |  |
|-----|--------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------|--|
| 9.  | Rated voltage factor                                                                             |                  | 1.2 continuous; 1.5 for 30 seconds                     |  |
| 10. | Type of Insulation                                                                               |                  |                                                        |  |
| 11. | Maximum temperature rise                                                                         | °C               |                                                        |  |
| 12. | Short-circuit withstand capability                                                               | kA rms           |                                                        |  |
| 13. | Primary insulation                                                                               |                  |                                                        |  |
| 14. | Lightning impulse withstand dry                                                                  | kV pk            |                                                        |  |
| 15. | (a) Power frequency withstand wet<br>(b) Power frequency withstand dry                           | kV rms<br>kV rms |                                                        |  |
| 16. | Partial discharge magnitude                                                                      | pC               |                                                        |  |
| 17. | Total external creepage distance                                                                 | mm               |                                                        |  |
| 18. | Radio influence voltage measured at $1.1 U_m/\sqrt{3}$ at 1 MHz                                  | μV               |                                                        |  |
| 19. | Total installed weight                                                                           | kg               |                                                        |  |
| 20. | Capacitance                                                                                      |                  |                                                        |  |
| 21. | High voltage capacitance (C1)                                                                    | pF               |                                                        |  |
| 22. | Intermediate - voltage capacitance (C2)                                                          | pF               |                                                        |  |
| 23. | Total Capacitance (C <sub>T</sub> )                                                              | pF               | 5000, +10% and -5%                                     |  |
| 24. | Open circuit intermediate voltage                                                                | kV               |                                                        |  |
| 25. | Rated open-circuit intermediate voltage                                                          | kV               |                                                        |  |
| 26. | Acceptable limit of variation of total capacitance over the entire carrier frequency range       |                  | + 50% and -20% of the rated capacitance                |  |
| 27. | Stray capacitance and stray conductance of low voltage terminal over the entire capacitance.     |                  | As per IEC-358                                         |  |
| 28. | Standard reference range of frequencies for which the accuracies are valid                       |                  | 97% to 103% for protection<br>99% to 101% for metering |  |
| 29. | High frequency capacitance for entire carrier frequency range                                    |                  | Within 80% to 150% of rated capacitance                |  |
| 30. | Equivalent series resistance over the entire carrier frequency range or temperature range (ohms) |                  | Less than 40                                           |  |
| 31. | Reference range of temperature                                                                   | °C               |                                                        |  |
| 32. | No. of Protective devices to limit overvoltage & location                                        |                  |                                                        |  |

### 1.4.1 245KV CAPACITIVE VOLTAGE TRANSFORMERS

| Sl. No. | Description                                                      | Unit   | Minimum Requirements               | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------|--------|------------------------------------|----------------------------------|
|         |                                                                  |        | 245KV                              |                                  |
| 33.     | Manufacturer & country of origin                                 |        |                                    |                                  |
| 34.     | Model Reference (Manufacturer's designation)                     |        |                                    |                                  |
| 35.     | Type No.                                                         | -      |                                    |                                  |
| 36.     | Transformer type                                                 | -      |                                    |                                  |
| 37.     | Rated primary voltage                                            | kV rms | 245 kV                             |                                  |
| 38.     | Rated Impedance                                                  |        |                                    |                                  |
| 39.     | Rated secondary voltage for each secondary winding               | kV rms |                                    |                                  |
| 40.     | Accuracy class for each winding<br>Rated output for each winding | VA     |                                    |                                  |
| 41.     | Rated voltage factor                                             |        | 1.2 continuous; 1.5 for 30 seconds |                                  |
| 42.     | Type of Insulation                                               |        |                                    |                                  |
| 43.     | Maximum temperature rise                                         | °C     |                                    |                                  |
| 44.     | Short-circuit withstand capability                               | kA rms |                                    |                                  |
| 45.     | Primary insulation                                               |        |                                    |                                  |
| 46.     | Lightning impulse withstand dry                                  | kV pk  |                                    |                                  |
| 47.     | (a) Power frequency withstand wet                                | kV rms |                                    |                                  |
|         | (b) Power frequency withstand dry                                | kV rms |                                    |                                  |
| 48.     | Partial discharge magnitude                                      | pC     |                                    |                                  |
| 49.     | Total external creepage distance                                 | mm     |                                    |                                  |
| 50.     | Radio influence voltage measured at $1.1 U_m/\sqrt{3}$ at 1 MHz  | μV     |                                    |                                  |
| 51.     | Total installed weight                                           | kg     |                                    |                                  |
| 52.     | Capacitance                                                      |        |                                    |                                  |
| 53.     | High voltage capacitance (C1)                                    | pF     |                                    |                                  |
| 54.     | Intermediate - voltage capacitance (C2)                          | pF     |                                    |                                  |
| 55.     | Total Capacitance (C <sub>T</sub> )                              | pF     | 4400, +10% and -5%                 |                                  |
| 56.     | Open circuit intermediate voltage                                | kV     |                                    |                                  |
| 57.     | Rated open-circuit intermediate voltage                          | kV     |                                    |                                  |

|     |                                                                                                  |    |                                                        |  |
|-----|--------------------------------------------------------------------------------------------------|----|--------------------------------------------------------|--|
| 58. | Acceptable limit of variation of total capacitance over the entire carrier frequency range       |    | + 50% and -20% of the rated capacitance                |  |
| 59. | Stray capacitance and stray conductance of low voltage terminal over the entire capacitance.     |    | As per IEC-358                                         |  |
| 60. | Standard reference range of frequencies for which the accuracies are valid                       |    | 97% to 103% for protection<br>99% to 101% for metering |  |
| 61. | High frequency capacitance for entire carrier frequency range                                    |    | Within 80% to 150% of rated capacitance                |  |
| 62. | Equivalent series resistance over the entire carrier frequency range or temperature range (ohms) |    | Less than 40                                           |  |
| 63. | Reference range of temperature                                                                   | °C |                                                        |  |
| 64. | No. of Protective devices to limit overvoltage & location                                        |    |                                                        |  |

## 1.4 VOLTAGE TRANSFORMERS

### 1.4.1 145KV VOLTAGE TRANSFORMERS

| Sl. No. | Description                                                      | Unit   | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------|--------|----------------------------|----------------------------------|
|         |                                                                  |        | 145KV                      |                                  |
| 1.      | Manufacturer & country of origin                                 | -      |                            |                                  |
| 2.      | Model Reference (Manufacturer's designation)                     |        |                            |                                  |
| 3.      | Transformer type                                                 | -      | Outdoor Inductive oil type |                                  |
| 4.      | Rated primary voltage                                            | kV rms | 145kV                      |                                  |
| 5.      | Rated Impedance                                                  |        |                            |                                  |
| 6.      | Rated secondary voltage for each secondary winding               | kV rms |                            |                                  |
| 7.      | Accuracy class for each winding<br>Rated output for each winding | VA     |                            |                                  |
| 8.      | Rated voltage factor                                             |        |                            |                                  |
| 9.      | Type of Insulation                                               |        |                            |                                  |
| 10.     | Maximum temperature rise                                         | °C     |                            |                                  |
| 11.     | Short-circuit withstand capability                               | kA rms |                            |                                  |
| 12.     | Primary insulation                                               |        | Class A                    |                                  |
| 13.     | Lightning impulse withstand dry                                  | kV pk  | 650 kVp                    |                                  |

| Sl. No. | Description                                                            | Unit             | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------------|------------------|----------------------------|----------------------------------|
|         |                                                                        |                  | 145KV                      |                                  |
| 14.     | (a) Power frequency withstand wet<br>(b) Power frequency withstand dry | kV rms<br>kV rms | 275 kVrms                  |                                  |
| 15.     | Partial discharge magnitude                                            | pC               | 10 pC                      |                                  |
| 16.     | Total external creepage distance                                       | mm               |                            |                                  |
| 17.     | Radio influence voltage measured at 1.1 Um/ $\sqrt{3}$ at 1 MHz        | $\mu$ V          | 1000 micro V (at 92 kVrms) |                                  |
| 18.     | Total installed weight                                                 | kg               |                            |                                  |
| 19.     | No. of Protective devices to limit overvoltage & location              |                  |                            |                                  |

#### 1.4.2 36KV VOLTAGE TRANSFORMERS

| Sl. No. | Description                                                            | Unit             | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|------------------------------------------------------------------------|------------------|----------------------------|----------------------------------|
|         |                                                                        |                  | 36KV                       |                                  |
| 20.     | Manufacturer & country of origin                                       | -                |                            |                                  |
| 21.     | Model Reference (Manufacturer's designation)                           |                  |                            |                                  |
| 22.     | Transformer type                                                       | -                | Outdoor Inductive oil type |                                  |
| 23.     | Rated primary voltage                                                  | kV rms           | 36kV                       |                                  |
| 24.     | Rated Impedance                                                        |                  |                            |                                  |
| 25.     | Rated secondary voltage for each secondary winding                     | kV rms           |                            |                                  |
| 26.     | Accuracy class for each winding<br>Rated output for each winding       | VA               |                            |                                  |
| 27.     | Rated voltage factor                                                   |                  |                            |                                  |
| 28.     | Type of Insulation                                                     |                  |                            |                                  |
| 29.     | Maximum temperature rise                                               | °C               |                            |                                  |
| 30.     | Short-circuit withstand capability                                     | kA rms           |                            |                                  |
| 31.     | Primary insulation                                                     |                  | Class A                    |                                  |
| 32.     | Lightning impulse withstand dry                                        | kV pk            | 170 kVp                    |                                  |
| 33.     | (a) Power frequency withstand wet<br>(b) Power frequency withstand dry | kV rms<br>kV rms | 70 kVrms                   |                                  |
| 34.     | Partial discharge magnitude                                            | pC               | 10 pC                      |                                  |
| 35.     | Total external creepage distance                                       | mm               |                            |                                  |

| Sl. No. | Description                                                     | Unit    | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|-----------------------------------------------------------------|---------|----------------------------|----------------------------------|
|         |                                                                 |         | 36KV                       |                                  |
| 36.     | Radio influence voltage measured at 1.1 Um/ $\sqrt{3}$ at 1 MHz | $\mu$ V | 1000 micro V (at 92 kVrms) |                                  |
| 37.     | Total installed weight                                          | kg      |                            |                                  |
| 38.     | No. of Protective devices to limit overvoltage & location       |         |                            |                                  |

## 1.5 SURGE ARRESTERS

### 1.5.1 420KV Surge Arrester

| Sl. No. | Description                                  | Unit   | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|----------------------------------------------|--------|----------------------------|----------------------------------|
|         |                                              |        | 420kV                      |                                  |
| 1.      | Manufacturer & country of origin             |        |                            |                                  |
| 2.      | Model Reference (Manufacturer's designation) |        |                            |                                  |
| 3.      | Max. highest system voltage                  |        | 420kV                      |                                  |
| 4.      | Type                                         |        | Outdoor type, ZnO, Gapless |                                  |
| 5.      | Standard                                     |        | IEC 60099-4                |                                  |
| 6.      | Rated voltage                                |        | 390kV                      |                                  |
| 7.      | Max. continuous operating voltage            |        | 303kVrms                   |                                  |
| 8.      | Nominal discharge current                    |        | 10kA                       |                                  |
| 9.      | Discharge class                              |        | Heavy duty 3               |                                  |
| 10.     | Surge counter                                |        | Yes                        |                                  |
| 11.     | Leakage current detector                     |        | Yes                        |                                  |
| 12.     | Applicable Standard                          |        |                            |                                  |
| 13.     | System Earthing                              |        |                            |                                  |
| 14.     | Rated Frequency                              |        |                            |                                  |
| 15.     | Rated system voltage                         |        |                            |                                  |
| 16.     | Highest system voltage                       |        |                            |                                  |
| 17.     | Continuous operating voltage                 | kV rms |                            |                                  |
| 18.     | Rated voltage                                | kV rms |                            |                                  |
| 19.     | Standard nominal discharge current           | kA     |                            |                                  |
| 20.     | Reference current at ambient temperature     | mA     |                            |                                  |
| 21.     | Reference voltage for above item no. 7       | kV rms |                            |                                  |
| 22.     | Currents at MCOV                             |        |                            |                                  |

|     |                                                                                                 |                         |  |  |
|-----|-------------------------------------------------------------------------------------------------|-------------------------|--|--|
| 23. | Residual Voltage                                                                                |                         |  |  |
| 24. | Steep current impulse residual voltage                                                          | kV pk                   |  |  |
| 25. | Protective Ratio                                                                                |                         |  |  |
| 26. | Lightning impulse residual voltage at<br>5kA<br>10kA<br>20kA                                    | kV pk<br>kV pk<br>kV pk |  |  |
| 27. | Duty Class                                                                                      |                         |  |  |
| 28. | Discharge class                                                                                 |                         |  |  |
| 29. | Pressure relief class                                                                           |                         |  |  |
| 30. | Minimum Energy Discharge Capability                                                             |                         |  |  |
| 31. | Temporary Over Voltage Capability at<br>0.1s<br>1s<br>10s<br>100s                               |                         |  |  |
| 32. | Nominal diameter of resistor blocks                                                             | mm                      |  |  |
| 33. | Number of resistor blocks connected electrically in parallel                                    |                         |  |  |
| 34. | Number of separately housed units per phase                                                     |                         |  |  |
| 35. | Overall height of arrester (without supporting structure)                                       | m                       |  |  |
| 36. | Overall height of arrester including grading ring if applicable                                 | mm                      |  |  |
| 37. | Clearances:<br>phase to earth (from centre line)<br>phase to phase (centre line to centre line) | mm<br>mm                |  |  |
| 38. | Overall Weight of arrester (without supporting structure)                                       | kg                      |  |  |
| 39. | Maximum cantilever strength                                                                     | Nm                      |  |  |
| 40. | Maximum force due to wind (at maximum specified gust speed)                                     | Nm                      |  |  |
| 41. | Minimum creepage distance over insulator housing                                                | mm                      |  |  |
| 42. | Insulator shed profile - Reference Document                                                     |                         |  |  |

|     |                                                             |  |  |  |
|-----|-------------------------------------------------------------|--|--|--|
| 43. | Terminal palm details - Drawing No.                         |  |  |  |
| 44. | Earthing terminal - Drawing No.                             |  |  |  |
| 45. | Type & Description of surge monitoring device               |  |  |  |
| 46. | Type test certificate ref/date                              |  |  |  |
| 47. | Number of the same type of surge arresters supplied to date |  |  |  |

### 1.5.2 245KV Surge Arrester

| Sl. No. | Description                                  | Unit   | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|----------------------------------------------|--------|----------------------------|----------------------------------|
|         |                                              |        | 245KV                      |                                  |
| 1.      | Manufacturer & country of origin             |        |                            |                                  |
| 2.      | Model Reference (Manufacturer's designation) |        |                            |                                  |
| 3.      | Max. highest system voltage                  |        | 245KV                      |                                  |
| 4.      | Type                                         |        | Outdoor type, ZnO, Gapless |                                  |
| 5.      | Standard                                     |        | IEC 60099-4                |                                  |
| 6.      | Rated voltage                                |        | 196kV                      |                                  |
| 7.      | Max. continuous operating voltage            |        | 160kVrms                   |                                  |
| 8.      | Nominal discharge current                    |        | 10kA                       |                                  |
| 9.      | Discharge class                              |        | Heavy duty 3               |                                  |
| 10.     | Surge counter                                |        | Yes                        |                                  |
| 11.     | Leakage current detector                     |        | Yes                        |                                  |
| 12.     | Applicable Standard                          |        |                            |                                  |
| 13.     | System Earthing                              |        |                            |                                  |
| 14.     | Rated Frequency                              |        |                            |                                  |
| 15.     | Rated system voltage                         |        |                            |                                  |
| 16.     | Highest system voltage                       |        |                            |                                  |
| 17.     | Continuous operating voltage                 | kV rms |                            |                                  |
| 18.     | Rated voltage                                | kV rms |                            |                                  |
| 19.     | Standard nominal discharge current           | kA     |                            |                                  |
| 20.     | Reference current at ambient temperature     | mA     |                            |                                  |
| 21.     | Reference voltage for above item no. 7       | kV rms |                            |                                  |

|     |                                                                                                 |                         |  |  |
|-----|-------------------------------------------------------------------------------------------------|-------------------------|--|--|
| 22. | Currents at MCOV                                                                                |                         |  |  |
| 23. | Residual Voltage                                                                                |                         |  |  |
| 24. | Steep current impulse residual voltage                                                          | kV pk                   |  |  |
| 25. | Protective Ratio                                                                                |                         |  |  |
| 26. | Lightning impulse residual voltage at<br>5kA<br>10kA<br>20kA                                    | kV pk<br>kV pk<br>kV pk |  |  |
| 27. | Duty Class                                                                                      |                         |  |  |
| 28. | Discharge class                                                                                 |                         |  |  |
| 29. | Pressure relief class                                                                           |                         |  |  |
| 30. | Minimum Energy Discharge Capability                                                             |                         |  |  |
| 31. | Temporary Over Voltage Capability at<br>0.1s<br>1s<br>10s<br>100s                               |                         |  |  |
| 32. | Nominal diameter of resistor blocks                                                             | mm                      |  |  |
| 33. | Number of resistor blocks connected electrically in parallel                                    |                         |  |  |
| 34. | Number of separately housed units per phase                                                     |                         |  |  |
| 35. | Overall height of arrester (without supporting structure)                                       | m                       |  |  |
| 36. | Overall height of arrester including grading ring if applicable                                 | mm                      |  |  |
| 37. | Clearances:<br>phase to earth (from centre line)<br>phase to phase (centre line to centre line) | mm<br>mm                |  |  |
| 38. | Overall Weight of arrester (without supporting structure)                                       | kg                      |  |  |
| 39. | Maximum cantilever strength                                                                     | Nm                      |  |  |
| 40. | Maximum force due to wind (at maximum specified gust speed)                                     | Nm                      |  |  |
| 41. | Minimum creepage distance over insulator housing                                                | mm                      |  |  |
| 42. | Insulator shed profile - Reference Document                                                     |                         |  |  |

|     |                                                             |  |  |  |
|-----|-------------------------------------------------------------|--|--|--|
| 43. | Terminal palm details - Drawing No.                         |  |  |  |
| 44. | Earthing terminal - Drawing No.                             |  |  |  |
| 45. | Type & Description of surge monitoring device               |  |  |  |
| 46. | Type test certificate ref/date                              |  |  |  |
| 47. | Number of the same type of surge arresters supplied to date |  |  |  |

### 1.5.3 145KV Surge Arrester

| Sl. No. | Description                                  | Unit   | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|----------------------------------------------|--------|----------------------------|----------------------------------|
|         |                                              |        | 145kV                      |                                  |
| 1.      | Manufacturer & country of origin             |        |                            |                                  |
| 2.      | Model Reference (Manufacturer's designation) |        |                            |                                  |
| 3.      | Max. highest system voltage                  |        | 145kV                      |                                  |
| 4.      | Type                                         |        | Outdoor type, ZnO, Gapless |                                  |
| 5.      | Standard                                     |        | IEC 60099-4                |                                  |
| 6.      | Rated voltage                                |        | 120kV                      |                                  |
| 7.      | Max. continuous operating voltage            |        | 102kVrms                   |                                  |
| 8.      | Nominal discharge current                    |        | 10kA                       |                                  |
| 9.      | Discharge class                              |        | Heavy duty 3               |                                  |
| 10.     | Surge counter                                |        | Yes                        |                                  |
| 11.     | Leakage current detector                     |        | Yes                        |                                  |
| 12.     | Applicable Standard                          |        |                            |                                  |
| 13.     | System Earthing                              |        |                            |                                  |
| 14.     | Rated Frequency                              |        |                            |                                  |
| 15.     | Rated system voltage                         |        |                            |                                  |
| 16.     | Highest system voltage                       |        |                            |                                  |
| 17.     | Continuous operating voltage                 | kV rms |                            |                                  |
| 18.     | Rated voltage                                | kV rms |                            |                                  |
| 19.     | Standard nominal discharge current           | kA     |                            |                                  |
| 20.     | Reference current at ambient temperature     | mA     |                            |                                  |
| 21.     | Reference voltage for above item no. 7       | kV     |                            |                                  |

|     |                                                                                                 |                         |  |  |
|-----|-------------------------------------------------------------------------------------------------|-------------------------|--|--|
|     |                                                                                                 | rms                     |  |  |
| 22. | Currents at MCOV                                                                                |                         |  |  |
| 23. | Residual Voltage                                                                                |                         |  |  |
| 24. | Steep current impulse residual voltage                                                          | kV pk                   |  |  |
| 25. | Protective Ratio                                                                                |                         |  |  |
| 26. | Lightning impulse residual voltage at<br>5kA<br>10kA<br>20kA                                    | kV pk<br>kV pk<br>kV pk |  |  |
| 27. | Duty Class                                                                                      |                         |  |  |
| 28. | Discharge class                                                                                 |                         |  |  |
| 29. | Pressure relief class                                                                           |                         |  |  |
| 30. | Minimum Energy Discharge Capability                                                             |                         |  |  |
| 31. | Temporary Over Voltage Capability at<br>0.1s<br>1s<br>10s<br>100s                               |                         |  |  |
| 32. | Nominal diameter of resistor blocks                                                             | mm                      |  |  |
| 33. | Number of resistor blocks connected electrically in parallel                                    |                         |  |  |
| 34. | Number of separately housed units per phase                                                     |                         |  |  |
| 35. | Overall height of arrester (without supporting structure)                                       | m                       |  |  |
| 36. | Overall height of arrester including grading ring if applicable                                 | mm                      |  |  |
| 37. | Clearances:<br>phase to earth (from centre line)<br>phase to phase (centre line to centre line) | mm<br>mm                |  |  |
| 38. | Overall Weight of arrester (without supporting structure)                                       | kg                      |  |  |
| 39. | Maximum cantilever strength                                                                     | Nm                      |  |  |
| 40. | Maximum force due to wind (at maximum specified gust speed)                                     | Nm                      |  |  |
| 41. | Minimum creepage distance over insulator housing                                                | mm                      |  |  |

|     |                                                             |  |  |  |
|-----|-------------------------------------------------------------|--|--|--|
| 42. | Insulator shed profile - Reference Document                 |  |  |  |
| 43. | Terminal palm details - Drawing No.                         |  |  |  |
| 44. | Earthing terminal - Drawing No.                             |  |  |  |
| 45. | Type & Description of surge monitoring device               |  |  |  |
| 46. | Type test certificate ref/date                              |  |  |  |
| 47. | Number of the same type of surge arresters supplied to date |  |  |  |

#### 1.5.4 36KV Surge Arrester

| Sl. No. | Description                                  | Unit   | Minimum Requirements       | Guaranteed Technical Particulars |
|---------|----------------------------------------------|--------|----------------------------|----------------------------------|
|         |                                              |        | 36kV                       |                                  |
| 1.      | Manufacturer & country of origin             |        |                            |                                  |
| 2.      | Model Reference (Manufacturer's designation) |        |                            |                                  |
| 3.      | Max. highest system voltage                  |        | 36kV                       |                                  |
| 4.      | Type                                         |        | Outdoor type, ZnO, Gapless |                                  |
| 5.      | Standard                                     |        | IEC 60099-4                |                                  |
| 6.      | Rated voltage                                |        | 30kV                       |                                  |
| 7.      | Max. continuous operating voltage            |        | 25kV                       |                                  |
| 8.      | Nominal discharge current                    |        | 10kA                       |                                  |
| 9.      | Discharge class                              |        | Heavy duty 3               |                                  |
| 10.     | Surge counter                                |        | Yes                        |                                  |
| 11.     | Leakage current detector                     |        | Yes                        |                                  |
| 12.     | Applicable Standard                          |        |                            |                                  |
| 13.     | System Earthing                              |        |                            |                                  |
| 14.     | Rated Frequency                              |        |                            |                                  |
| 15.     | Rated system voltage                         |        |                            |                                  |
| 16.     | Highest system voltage                       |        |                            |                                  |
| 17.     | Continuous operating voltage                 | kV rms |                            |                                  |
| 18.     | Rated voltage                                | kV rms |                            |                                  |
| 19.     | Standard nominal discharge current           | kA     |                            |                                  |

|     |                                                                                                 |                         |  |  |
|-----|-------------------------------------------------------------------------------------------------|-------------------------|--|--|
| 20. | Reference current at ambient temperature                                                        | mA                      |  |  |
| 21. | Reference voltage for above item no. 7                                                          | kV<br>rms               |  |  |
| 22. | Currents at MCOV                                                                                |                         |  |  |
| 23. | Residual Voltage                                                                                |                         |  |  |
| 24. | Steep current impulse residual voltage                                                          | kV pk                   |  |  |
| 25. | Protective Ratio                                                                                |                         |  |  |
| 26. | Lightning impulse residual voltage at<br>5kA<br>10kA<br>20kA                                    | kV pk<br>kV pk<br>kV pk |  |  |
| 27. | Duty Class                                                                                      |                         |  |  |
| 28. | Discharge class                                                                                 |                         |  |  |
| 29. | Pressure relief class                                                                           |                         |  |  |
| 30. | Minimum Energy Discharge Capability                                                             |                         |  |  |
| 31. | Temporary Over Voltage Capability at<br>0.1s<br>1s<br>10s<br>100s                               |                         |  |  |
| 32. | Nominal diameter of resistor blocks                                                             | mm                      |  |  |
| 33. | Number of resistor blocks connected electrically in parallel                                    |                         |  |  |
| 34. | Number of separately housed units per phase                                                     |                         |  |  |
| 35. | Overall height of arrester (without supporting structure)                                       | m                       |  |  |
| 36. | Overall height of arrester including grading ring if applicable                                 | mm                      |  |  |
| 37. | Clearances:<br>phase to earth (from centre line)<br>phase to phase (centre line to centre line) | mm<br>mm                |  |  |
| 38. | Overall Weight of arrester (without supporting structure)                                       | kg                      |  |  |
| 39. | Maximum cantilever strength                                                                     | Nm                      |  |  |
| 40. | Maximum force due to wind (at maximum specified gust speed)                                     | Nm                      |  |  |

|     |                                                             |    |  |  |
|-----|-------------------------------------------------------------|----|--|--|
| 41. | Minimum creepage distance over insulator housing            | mm |  |  |
| 42. | Insulator shed profile - Reference Document                 |    |  |  |
| 43. | Terminal palm details - Drawing No.                         |    |  |  |
| 44. | Earthing terminal - Drawing No.                             |    |  |  |
| 45. | Type & Description of surge monitoring device               |    |  |  |
| 46. | Type test certificate ref/date                              |    |  |  |
| 47. | Number of the same type of surge arresters supplied to date |    |  |  |

## 1.6 STEEL STRUCTURES, CONDUCTOR ,INSULATOR SETS &amp; FITTINGS

| No             | Description                                                        | Unit               | Minimum Requirements | Guaranteed |
|----------------|--------------------------------------------------------------------|--------------------|----------------------|------------|
| <b>1</b>       | <b>Structural Steel</b>                                            |                    |                      |            |
| <b>1.1</b>     | Type and standard specification                                    |                    | Insert               |            |
| <b>1.2</b>     | Manufacturer and country                                           |                    | Insert               |            |
| <b>1.3</b>     | Minimum yield strength                                             | kg/mm <sup>2</sup> | Insert               |            |
| <b>1.4</b>     | Ultimate tensile strength                                          | kg/mm <sup>2</sup> | Insert               |            |
| <b>2.</b>      | <b>Copper Conductors for Earthing system</b>                       |                    |                      |            |
| <b>2.1</b>     | Type and standard specification                                    |                    | Insert               |            |
| <b>2.2</b>     | Manufacturer and country                                           |                    | Insert               |            |
| <b>2.3</b>     | Conductor material                                                 |                    | Insert               |            |
| <b>2.4</b>     | Size of conductors<br>(Solid copper rods)                          | mm <sup>2</sup>    | Insert               |            |
| <b>2.5</b>     | Size of conductors (Flat copper bars)<br>(Width×Thickness×Bundles) | mm                 | Insert               |            |
| <b>2.6</b>     | Rated current                                                      | A                  | Insert               |            |
| <b>2.7</b>     | Short time withstand current                                       | kA rms             | Insert               |            |
| <b>2.8</b>     | Peak withstand current                                             | kA pk              | Insert               |            |
| <b>3</b>       | <b>High Voltage Bus Work</b>                                       |                    |                      |            |
| <b>3.1</b>     | <b>Switchyard Conductor</b>                                        |                    |                      |            |
| <b>3.1.1</b>   | <b>Copper Tubular Conductors for Busbar</b>                        |                    |                      |            |
| <b>3.1.1.1</b> | Type and standard specification                                    |                    | Insert               |            |
| <b>3.1.1.2</b> | Manufacturer and country                                           |                    | Insert               |            |
| <b>3.1.1.3</b> | Inner diameter                                                     | mm                 | Insert               |            |
| <b>3.1.1.4</b> | Outer diameter                                                     | mm                 | Insert               |            |
| <b>3.1.1.5</b> | Rated continuous current (site rating)                             | A rms              | Insert               |            |
| <b>3.1.1.6</b> | Temperature rise at rated current                                  | °C                 | Insert               |            |
| <b>3.1.1.7</b> | Rated short time current                                           | kA rms             | Insert               |            |
| <b>3.1.1.8</b> | Peak withstand current                                             | kA pk              | Insert               |            |
| <b>3.1.1.9</b> | Weight                                                             | kg/m               | Insert               |            |
| <b>3.1.2</b>   | <b>Aluminium Tubular Conductors for Busbar</b>                     |                    |                      |            |
| <b>3.1.2.1</b> | Type and standard specification                                    |                    | Insert               |            |

| No           | Description                                     | Unit              | Minimum Requirements | Guaranteed |
|--------------|-------------------------------------------------|-------------------|----------------------|------------|
| 3.1.2.2      | Manufacturer and country                        |                   | Insert               |            |
| 3.1.2.3      | Inner diameter                                  | mm                | Insert               |            |
| 3.1.2.4      | Outer diameter                                  | mm                | Insert               |            |
| 3.1.2.5      | Rated continuous current (site rating)          | A rms             | Insert               |            |
| 3.1.2.6      | Temperature rise at rated current               | °C                | Insert               |            |
| 3.1.2.7      | Rated short time current                        | kA rms            | Insert               |            |
| 3.1.2.8      | Peak withstand current                          | kA pk             | Insert               |            |
| 3.1.2.9      | Weight                                          | kg/m              | Insert               |            |
| 3.1.2.10     | Moment of inertia                               | kg-m <sup>2</sup> | Insert               |            |
| 3.1.2.11     | Temperature rise at rated current               | °C                | Insert               |            |
| 3.1.2.12     | Rated short time current                        | kA rms            | Insert               |            |
| 3.1.2.13     | Peak withstand current                          | kA pk             | Insert               |            |
| 3.1.2.14     | Rated ultimate tensile strength                 | kN                | Insert               |            |
| 3.1.2.15     | Mass, nominal                                   | kg/m              | Insert               |            |
| 3.1.2.16     | No. of conductors per bundle                    |                   | Insert               |            |
| 3.1.2.17     | Bundle configuration                            |                   | Insert               |            |
| 3.1.2.18     | Bundle spacing                                  |                   |                      |            |
| <b>3.1.3</b> | <b>Flexible Bus Conductor</b>                   |                   |                      |            |
|              | Type and standard specification                 |                   | Insert               |            |
|              | Manufacturer and country                        |                   | Insert               |            |
|              | Conductor type                                  |                   | Insert               |            |
|              | Conductor size                                  |                   | Insert               |            |
|              | Standing<br>- No. of Al wires Dia. Of each wire | mm                | Insert               |            |
|              | Overall conductor dia.                          | mm                | Insert               |            |
|              | Cross-sectional area                            | mm <sup>2</sup>   | Insert               |            |
|              | Rated continuous current (site rating)          | A rms             | Insert               |            |
|              | Temperature rise at rated current               | °C                | Insert               |            |
|              | Rated short time current                        | kA rms            | Insert               |            |
|              | Peak withstand current                          | kA pk             | Insert               |            |
|              | Rated ultimate tensile strength                 | kN                | Insert               |            |
|              | Mass, nominal                                   | kg/m              | Insert               |            |
|              | No. of conductors per bundle                    |                   | Insert               |            |
|              | Bundle configuration                            |                   | Insert               |            |
|              | Bundle spacing                                  |                   | Insert               |            |

| No           | Description                       | Unit  | Minimum Requirements | Guaranteed |
|--------------|-----------------------------------|-------|----------------------|------------|
| <b>3.1.4</b> | <b>Shield Wire</b>                |       |                      |            |
|              | Type and standard specification   |       | Insert               |            |
|              | Manufacturer and country          |       | Insert               |            |
|              | Dia. of galvanized steel wire     | mm    | Insert               |            |
|              | Stranding<br>- No. of Al wires    | mm    | Insert               |            |
|              | Dia. Of each wire                 | mm    | Insert               |            |
|              | Grade of wire                     |       | Insert               |            |
|              | Weight of wire                    | kg/km | Insert               |            |
|              | Minimum breaking strength of wire | kN    | Insert               |            |

### 1.7 Insulators

| No           | Description                                       | Unit     | Minimum Requirements | Guaranteed |
|--------------|---------------------------------------------------|----------|----------------------|------------|
| <b>3.2</b>   | <b>Insulators</b>                                 |          |                      |            |
| <b>3.2.1</b> | <b>Station Post Type (for rigid Busbar)</b>       |          |                      |            |
|              | Type and standard specification                   |          | Insert               |            |
|              | Manufacturer and country                          |          | Insert               |            |
|              | Insulator unit, length/height                     | mm       | Insert               |            |
|              | No. of units in each insulator                    |          | Insert               |            |
|              | Power frequency flashover voltage<br>- Dry<br>Wet | kV<br>kV | Insert               |            |

| No           | Description                                                                                                                                                                                                   | Unit                   | Minimum Requirements | Guaranteed |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------|------------|
|              | Impulse flashover voltage<br>- Positive<br>Negative                                                                                                                                                           | kV/kV                  | Insert               |            |
|              | Power frequency withstand voltage<br>- 1 min. dry<br>10 sec. wet                                                                                                                                              | kV/kV                  | Insert               |            |
|              | Power frequency puncture voltage                                                                                                                                                                              | kV                     | Insert               |            |
|              | Switching impulse withstand voltage, wet                                                                                                                                                                      | kV pk                  | Insert               |            |
|              | Lightning impulse withstand voltage                                                                                                                                                                           | kV pk                  | Insert               |            |
|              | Radio interference voltage<br>- Test voltage to ground<br>Max. RIV at 1.1xUr//3 line to ground voltage, when tested as per IEC 60694                                                                          | kV rms<br>micro V      | Insert               |            |
|              | Leakage distance                                                                                                                                                                                              | mm                     | Insert               |            |
|              | Mechanical values, failing load (min.)<br>- Cantilever strength<br>- Tensile strength<br>- Torsional strength<br>- Compressional strength<br>- Combined electrical and mechanical strength<br>Impact strength | NN<br>N-mN<br>N<br>N-m | Insert               |            |
| <b>3.2.2</b> | <b>String Type</b>                                                                                                                                                                                            |                        | Insert               |            |
|              | Type and standard specification                                                                                                                                                                               |                        | Insert               |            |
|              | Manufacturer and country                                                                                                                                                                                      |                        | Insert               |            |
|              | Insulator unit, length                                                                                                                                                                                        | mm                     | Insert               |            |
|              | No. of units in each insulator                                                                                                                                                                                |                        | Insert               |            |
|              | No. of insulator strings per conductor (at each end)                                                                                                                                                          |                        | Insert               |            |
|              | Dia. of disc                                                                                                                                                                                                  | mm                     | Insert               |            |
|              | Disc spacing                                                                                                                                                                                                  | mm                     | Insert               |            |
|              | Power frequency flashover voltage<br>- Dry<br>Wet                                                                                                                                                             | kV/kV                  | Insert               |            |
|              | Impulse flashover voltage<br>- Positive                                                                                                                                                                       | kV                     | Insert               |            |

| No         | Description                                                                                                                                                                             | Unit                 | Minimum Requirements | Guaranteed |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|------------|
|            | Negative                                                                                                                                                                                | kV                   |                      |            |
|            | Power frequency withstand voltage<br>- 1 min. dry<br>10 sec. wet                                                                                                                        | kV                   | Insert               |            |
|            | Power frequency puncture voltage                                                                                                                                                        | kV                   | Insert               |            |
|            | Switching impulse withstand voltage, wet                                                                                                                                                | kV pk                | Insert               |            |
|            | Lightning impulse withstand voltage                                                                                                                                                     | kV pk                | Insert               |            |
|            | Dry arcing distance                                                                                                                                                                     | mm                   | Insert               |            |
|            | Radio interference voltage<br>- Test voltage to ground<br>Max. RIV at 1.1xUr//3 line to ground<br>voltage, when tested as per IEC 60694                                                 | kV rms<br>micro V    | Insert               |            |
|            | Leakage distance                                                                                                                                                                        | mm                   | Insert               |            |
|            | Mechanical values, failing load (min.)<br>- Tensile strength<br>- Torsional strength<br>- Compressional strength<br>- Combined electrical and<br>mechanical strength<br>Impact strength | N<br>N-m<br>N<br>N-m | Insert               |            |
| <b>3.3</b> | <b>Clamps and Fittings</b>                                                                                                                                                              |                      |                      |            |
|            | Type and standard specification                                                                                                                                                         |                      | Insert               |            |
|            | Manufacturer and country                                                                                                                                                                |                      | Insert               |            |
|            | Maximum working stresses                                                                                                                                                                |                      | Insert               |            |
|            | All accessories for installation<br>(bolts, nuts, etc.)                                                                                                                                 |                      | Insert               |            |

## 1.8 Post Insulator (400kV)

| No.  | Description                                                | Minimum Requirements |                                                     | Guaranteed |
|------|------------------------------------------------------------|----------------------|-----------------------------------------------------|------------|
|      |                                                            | Unit                 | Data                                                |            |
| 1.   | Post Insulators - General                                  |                      |                                                     |            |
| 1.1  | Manufacturer                                               |                      | Insert                                              |            |
| 1.2  | Type                                                       |                      | Insert                                              |            |
| 1.3  | Model designation                                          |                      | Insert                                              |            |
| 1.4  | Country of origin                                          |                      | Insert                                              |            |
| 1.5  | Standards                                                  |                      | IEC 60168<br>IEC 60273<br>IEC 60672<br>IEC 60694    |            |
| 1.6  | Quality control                                            |                      | ISO 9001                                            |            |
| 1.7  | Design                                                     |                      | Solid core, porcelain,<br>outdoor                   |            |
| 2    | Post Insulators - Characteristics                          |                      |                                                     |            |
| 2.1  | Nominal system voltage                                     | kV <sub>rms</sub>    | 400                                                 |            |
| 2.2  | Highest voltage for equipment U <sub>n</sub>               | kV <sub>rms</sub>    | 420                                                 |            |
| 2.3  | Rated lightning impulse withstand voltage<br>(Wet and Dry) | kV <sub>peak</sub>   | 1425                                                |            |
| 2.4  | Rated switching impulse withstand voltage                  | kV <sub>peak</sub>   | 1050                                                |            |
| 2.5  | One min. power freq. withstand voltage<br>(Wet and Dry)    | kVrms                | 630                                                 |            |
| 2.6  | Rated frequency f <sub>r</sub>                             | Hz                   | 50                                                  |            |
| 2.7  | Minimum creepage distance                                  | mm/kV                | Min. ≥ 25 mm/kV                                     |            |
| 2.8  | Total creepage distance, pedestal                          | mm                   | Min. ≥ 10500 mm                                     |            |
| 2.9  | Failing load bending (p0) (C10)                            | N                    | ≥ 12500<br>Calculation is required<br>during design |            |
| 2.10 | Failing load torsion                                       | Nm                   | ≥ 4000<br>Calculation is required<br>during design  |            |

| No.                                                                                           | Description                                     | Minimum Requirements |                  | Guaranteed |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------|------------------|------------|
|                                                                                               |                                                 | Unit                 | Data             |            |
| 2.11                                                                                          | Total min. cantilever strength                  | kg                   | ≥ 1000           |            |
| 2.12                                                                                          | Corona extinction voltage                       | (kVrms)              | 320              |            |
| <b>3</b>                                                                                      | Post Insulators - Design and Construction       |                      |                  |            |
| 3.1                                                                                           | Insulation material                             |                      | Porcelain, brown |            |
| 3.2                                                                                           | Material quality acc. IEC 60672                 |                      | Min. C130        |            |
| 3.3                                                                                           | Min. material density $\rho_a$                  | Mgm <sup>-3</sup>    | ≥ 2.5            |            |
| 3.4                                                                                           | Min. stretch strength of material $\sigma_{fg}$ | MPa                  | ≥ 140            |            |
| 3.5                                                                                           | Insulator height                                | mm                   | Insert           |            |
| 3.5.1                                                                                         | Total min. height of insulator                  | (mm)                 | ≥ 3500           |            |
| 3.6                                                                                           | Max. diameter of insulating part                | mm                   | Insert           |            |
| 3.7                                                                                           | Diameter of upper base                          | mm                   | Insert           |            |
| 3.8                                                                                           | Number of holes on upper base                   |                      | Insert           |            |
| 3.9                                                                                           | Diameter distance between holes on upper base   | mm                   | Insert           |            |
| 3.10                                                                                          | Hole type on upper base                         |                      | Insert           |            |
| 3.11                                                                                          | Diameter on lower base                          | mm                   | Insert           |            |
| 3.12                                                                                          | Number of holes on lower base                   |                      | Insert           |            |
| 3.13                                                                                          | Diameter distance between holes on lower base   | mm                   | Insert           |            |
| 3.14                                                                                          | Hole type on lower base                         |                      | Insert           |            |
| 3.15                                                                                          | Insulator weight                                | kg                   | Insert           |            |
| <b>Overall compliance with the requirements &amp; detail specification described in Vol-2</b> |                                                 | <b>Yes</b>           |                  |            |

## 1.9 Post Insulator (230kV)

| No.  | Description                                                | Minimum Requirements |                                                     | Guaranteed |
|------|------------------------------------------------------------|----------------------|-----------------------------------------------------|------------|
|      |                                                            | Unit                 | Data                                                |            |
| 1.   | Post Insulators - General                                  |                      |                                                     |            |
| 1.1  | Manufacturer                                               |                      | Insert                                              |            |
| 1.2  | Type                                                       |                      | Insert                                              |            |
| 1.3  | Model designation                                          |                      | Insert                                              |            |
| 1.4  | Country of origin                                          |                      | Insert                                              |            |
| 1.5  | Standards                                                  |                      | IEC 60168<br>IEC 60273<br>IEC 60672<br>IEC 60694    |            |
| 1.6  | Quality control                                            |                      | ISO 9001                                            |            |
| 1.7  | Design                                                     |                      | Solid core, porcelain,<br>outdoor                   |            |
| 2    | Post Insulators - Characteristics                          |                      |                                                     |            |
| 2.1  | Nominal system voltage                                     | kV <sub>rms</sub>    | 230                                                 |            |
| 2.2  | Highest voltage for equipment U <sub>n</sub>               | kV <sub>rms</sub>    | 245                                                 |            |
| 2.3  | Rated lightning impulse withstand voltage<br>(Wet and Dry) | kV <sub>peak</sub>   | 1050                                                |            |
| 2.4  | Rated switching impulse withstand voltage                  | kV <sub>peak</sub>   | 850                                                 |            |
| 2.5  | One min. power freq. withstand voltage<br>(Wet and Dry)    | kVrms                | 460                                                 |            |
| 2.6  | Rated frequency f <sub>r</sub>                             | Hz                   | 50                                                  |            |
| 2.7  | Minimum creepage distance                                  | mm/kV                | Min. ≥ 25 mm/kV                                     |            |
| 2.8  | Total creepage distance, pedestal                          | mm                   | Min. ≥ 6125 mm                                      |            |
| 2.9  | Failing load bending (p0) (C10)                            | N                    | ≥ 10000<br>Calculation is required<br>during design |            |
| 2.10 | Failing load torsion                                       | Nm                   | ≥ 4000<br>Calculation is required<br>during design  |            |

| No.                                                                                           | Description                                     | Minimum Requirements |                  | Guaranteed |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------|------------------|------------|
|                                                                                               |                                                 | Unit                 | Data             |            |
| 2.11                                                                                          | Total min. cantilever strength                  | kg                   | $\geq 800$       |            |
| 2.12                                                                                          | Corona extinction voltage                       | kVrms                | 156              |            |
| <b>3</b>                                                                                      | Post Insulators - Design and Construction       |                      |                  |            |
| 3.1                                                                                           | Insulation material                             |                      | Porcelain, brown |            |
| 3.2                                                                                           | Material quality acc. IEC 60672                 |                      | Min. C130        |            |
| 3.3                                                                                           | Min. material density $\rho_a$                  | Mgm <sup>-3</sup>    | $\geq 2.5$       |            |
| 3.4                                                                                           | Min. stretch strength of material $\sigma_{fg}$ | MPa                  | $\geq 140$       |            |
| 3.5                                                                                           | Insulator height                                | mm                   | Insert           |            |
| 3.5.1                                                                                         | Total min. height of insulator                  | (mm)                 | $\geq 2500$      |            |
| 3.6                                                                                           | Max. diameter of insulating part                | mm                   | Insert           |            |
| 3.7                                                                                           | Diameter of upper base                          | mm                   | Insert           |            |
| 3.8                                                                                           | Number of holes on upper base                   |                      | Insert           |            |
| 3.9                                                                                           | Diameter distance between holes on upper base   | mm                   | Insert           |            |
| 3.10                                                                                          | Hole type on upper base                         |                      | Insert           |            |
| 3.11                                                                                          | Diameter on lower base                          | mm                   | Insert           |            |
| 3.12                                                                                          | Number of holes on lower base                   |                      | Insert           |            |
| 3.13                                                                                          | Diameter distance between holes on lower base   | mm                   | Insert           |            |
| 3.14                                                                                          | Hole type on lower base                         |                      | Insert           |            |
| 3.15                                                                                          | Insulator weight                                | kg                   | Insert           |            |
| <b>Overall compliance with the requirements &amp; detail specification described in Vol-2</b> |                                                 | <b>Yes</b>           |                  |            |

## 1.10 Post Insulator (132kV)

| No.  | Description                                                | Minimum Requirements |                                                    | Guaranteed |
|------|------------------------------------------------------------|----------------------|----------------------------------------------------|------------|
|      |                                                            | Unit                 | Data                                               |            |
| 1.   | Post Insulators - General                                  |                      |                                                    |            |
| 1.1  | Manufacturer                                               |                      | Insert                                             |            |
| 1.2  | Type                                                       |                      | Insert                                             |            |
| 1.3  | Model designation                                          |                      | Insert                                             |            |
| 1.4  | Country of origin                                          |                      | Insert                                             |            |
| 1.5  | Standards                                                  |                      | IEC 60168<br>IEC 60273<br>IEC 60672<br>IEC 60694   |            |
| 1.6  | Quality control                                            |                      | ISO 9001                                           |            |
| 1.7  | Design                                                     |                      | Solid core, porcelain,<br>outdoor                  |            |
| 2    | Post Insulators - Characteristics                          |                      |                                                    |            |
| 2.1  | Nominal system voltage                                     | kV <sub>rms</sub>    | 132                                                |            |
| 2.2  | Highest voltage for equipment U <sub>n</sub>               | kV <sub>rms</sub>    | 145                                                |            |
| 2.3  | Rated lightning impulse withstand voltage                  | kV <sub>peak</sub>   | 650                                                |            |
| 2.4  | Rated switching impulse withstand voltage<br>(Wet and Dry) | kV <sub>peak</sub>   | -                                                  |            |
| 2.5  | One min. power freq. withstand voltage<br>(Wet and Dry)    | kVrms                | 275                                                |            |
| 2.6  | Rated frequency f <sub>r</sub>                             | Hz                   | 50                                                 |            |
| 2.7  | Minimum creepage distance                                  | mm/kV                | Min. ≥ 25 mm/kV                                    |            |
| 2.8  | Total creepage distance, pedestal                          | mm                   | Min. ≥ 3625 mm                                     |            |
| 2.9  | Failing load bending (p0) (C10)                            | N                    | ≥ 10000<br>Calculation is required<br>duringdesign |            |
| 2.10 | Failing load torsion                                       | Nm                   | ≥ 4000<br>Calculation is required<br>during design |            |

| No.                                                                                           | Description                                     | Minimum Requirements |                  | Guaranteed |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------|------------------|------------|
|                                                                                               |                                                 | Unit                 | Data             |            |
| 2.11                                                                                          | Total min. cantilever strength                  | kg                   | $\geq 800$       |            |
| 2.12                                                                                          | Corona extinction voltage                       | kVrms                | Insert           |            |
| <b>3</b>                                                                                      | Post Insulators - Design and Construction       |                      |                  |            |
| 3.1                                                                                           | Insulation material                             |                      | Porcelain, brown |            |
| 3.2                                                                                           | Material quality acc. IEC 60672                 |                      | Min. C130        |            |
| 3.3                                                                                           | Min. material density $\rho_a$                  | Mgm <sup>-3</sup>    | $\geq 2.5$       |            |
| 3.4                                                                                           | Min. stretch strength of material $\sigma_{fg}$ | MPa                  | $\geq 140$       |            |
| 3.5                                                                                           | Insulator height                                | mm                   | Insert           |            |
| 3.5.1                                                                                         | Total min. height of insulator                  | mm                   | $\geq 2500$      |            |
| 3.6                                                                                           | Max. diameter of insulating part                | mm                   | Insert           |            |
| 3.7                                                                                           | Diameter of upper base                          | mm                   | Insert           |            |
| 3.8                                                                                           | Number of holes on upper base                   |                      | Insert           |            |
| 3.9                                                                                           | Diameter distance between holes on upper base   | mm                   | Insert           |            |
| 3.10                                                                                          | Hole type on upper base                         |                      | Insert           |            |
| 3.11                                                                                          | Diameter on lower base                          | mm                   | Insert           |            |
| 3.12                                                                                          | Number of holes on lower base                   |                      | Insert           |            |
| 3.13                                                                                          | Diameter distance between holes on lower base   | mm                   | Insert           |            |
| 3.14                                                                                          | Hole type on lower base                         |                      | Insert           |            |
| 3.15                                                                                          | Insulator weight                                | kg                   | Insert           |            |
| <b>Overall compliance with the requirements &amp; detail specification described in Vol-2</b> |                                                 | <b>Yes</b>           |                  |            |

## PART 2 – TRANSFORMERS

### 2.1 400/230/33 kV, 400/520MVA, 3-PHASE POWER TRANSFORMER:

| No.      | Description                                                                                 | Minimum Requirements |                                                                                                                                       | Guaranteed |
|----------|---------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------|
|          |                                                                                             | Unit                 | Data                                                                                                                                  |            |
| <b>1</b> | <b>General</b>                                                                              |                      |                                                                                                                                       |            |
| 1.1      | Manufacturer                                                                                |                      | Insert                                                                                                                                |            |
| 1.2      | Type                                                                                        |                      | Autotransformer three-phase, oil immersed, with tertiary winding, hermetically sealed, with on-load tap changer, outdoor              |            |
| 1.3      | Model designation                                                                           |                      | Insert                                                                                                                                |            |
| 1.4      | Country of origin                                                                           |                      | Insert                                                                                                                                |            |
| 1.5      | Standards                                                                                   |                      | IEC 60044<br>IEC 60076<br>IEC 60137<br>IEC 60214<br>IEC 60354<br>IEC 60529<br>IEC 60815<br>IEC 60947<br>NEMA TR-1<br>CENELEC EN 50216 |            |
| 1.6      | Quality control                                                                             |                      | ISO 9001                                                                                                                              |            |
| 1.7      | Tertiary winding function                                                                   |                      | Stabilizing winding & auxiliary power supply                                                                                          |            |
| 1.8      | Thermal insulation class                                                                    |                      | A                                                                                                                                     |            |
| <b>2</b> | <b>Ratings and properties</b>                                                               |                      |                                                                                                                                       |            |
| 2.1      | Rated power:<br>• Primary / secondary winding<br>• Tertiary - minimum                       | MVA<br>MVA           | 520 / 520<br>≥ 104                                                                                                                    |            |
| 2.2      | Rated power by cooling ONAN / ONAF<br>• Primary / secondary winding<br>• Tertiary - minimum | MVA<br>MVA           | 400 / 520<br>≥ 80 / ≥ 104                                                                                                             |            |
| 2.3      | Rated voltage of windings:<br>• HV winding<br>• MV winding<br>• LV - stabilizing winding    | kV<br>kV<br>kV       | 400<br>230<br>33                                                                                                                      |            |
| 2.4      | Tap changer:                                                                                |                      |                                                                                                                                       |            |
|          | • Manufacturer                                                                              |                      | Insert                                                                                                                                |            |
|          | • Country of origin                                                                         |                      | Insert                                                                                                                                |            |
|          | • Model designation                                                                         |                      | insert                                                                                                                                |            |
|          | • Type of tap changing                                                                      |                      | On-load                                                                                                                               |            |
|          | • Tap changer location                                                                      |                      | At High voltage side                                                                                                                  |            |
|          | • Type of voltage regulation                                                                | %                    | C.F.V.V.                                                                                                                              |            |
|          | • Tapping range                                                                             | %                    | ±10                                                                                                                                   |            |
|          | •                                                                                           |                      |                                                                                                                                       |            |
|          | • Tapping step                                                                              |                      | 1.25                                                                                                                                  |            |
|          | • Rating                                                                                    |                      | Rated power 520 MVA, all taps                                                                                                         |            |

| No.      | Description                                                                                                                                                                                     | Minimum Requirements   |                                                                    | Guaranteed |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------|------------|
|          |                                                                                                                                                                                                 | Unit                   | Data                                                               |            |
| 2.5      | Frequency                                                                                                                                                                                       | Hz                     | 50                                                                 |            |
| 2.6      | Connection of three-phase windings (group of vector IEC 60076)                                                                                                                                  |                        | YNa0d1                                                             |            |
| 2.7      | Neutral point insulation                                                                                                                                                                        |                        | Li95                                                               |            |
| 2.8      | Low voltage winding connection (LV)                                                                                                                                                             |                        | closed delta, with three terminals brought out outside of the tank |            |
| 2.9      | Type of oil preservation system                                                                                                                                                                 |                        | Air Cell                                                           |            |
| 2.10     | Maximum acceptable noise level                                                                                                                                                                  |                        | 78dB                                                               |            |
| <b>3</b> | <b>Special technical requirements</b>                                                                                                                                                           |                        |                                                                    |            |
| 3.1      | Short circuit impedance corrected to reference temperature of 75°C at rated frequency and rated power                                                                                           |                        |                                                                    |            |
| 3.1.1    | HV - MV, on the basis of rated power with on-load tap changer in middle position                                                                                                                | %                      | <b>13 ±10 %</b>                                                    |            |
| 3.1.2    | HV - LV, on the basis of rated power with on-load tap changer in middle position                                                                                                                | %                      | Insert                                                             |            |
| 3.1.3    | MV - LV, on the basis of rated power 'x' MVA with on-load tap changer in middle position                                                                                                        | %                      | Insert                                                             |            |
| 3.2      | Zero-sequence impedance, with tap changer in middle position:<br>• HV/MV<br>• HV/LV<br>• MV/LV                                                                                                  | %<br>%<br>%            | Insert<br>Insert<br>Insert                                         |            |
| 3.3      | Autotransformer capacity to withstand external short circuits                                                                                                                                   |                        |                                                                    |            |
| 3.3.1    | Short-circuit duration                                                                                                                                                                          | s                      | 2                                                                  |            |
| 3.3.2    | Symmetrical short-circuit with-stand capacity and asymmetrical short-circuit withstand capacity during indicated period:<br>• HV winding<br>• MV winding<br>• LV winding<br>• Pre-fault voltage | kA<br>kA<br>kA<br>p.u. | 63<br>50<br>31.5<br>1.05                                           |            |
| 3.4      | Guaranteed losses                                                                                                                                                                               |                        |                                                                    |            |
| 3.4.1    | a. No-load losses with tap changer in nominal tap position:<br>at rated voltage and rated frequency                                                                                             | kW                     | <b>Insert</b>                                                      |            |
|          | b. No-load losses with tap changer in nominal tap position at 110% rated voltage and rated frequency                                                                                            | kW                     | <b>Insert</b>                                                      |            |
|          | c. No-load losses with tap changer in nominal tap position at 90% rated voltage, at rated frequency                                                                                             | kW                     | Insert                                                             |            |
|          | d. average no load loss (this value will be evaluated)                                                                                                                                          | kW                     | <b>(a+b+c)/3</b>                                                   |            |
| 3.4.2    | No-load losses capitalized value                                                                                                                                                                | BDT/kW                 | <b>As per vol 1 of tender doc</b>                                  |            |
| 3.4.3    | Tolerance to be applied to no-load losses in % of the guaranteed value                                                                                                                          | %                      | 10                                                                 |            |

| No.    | Description                                                                                                                                                                   | Minimum Requirements |                                      | Guaranteed |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------|------------|
|        |                                                                                                                                                                               | Unit                 | Data                                 |            |
| 3.4.4  | a. On-load losses at 75°C, with tap changer in nominal position and at rated current of that tap position                                                                     | kW                   | Insert                               |            |
|        | b. On-load losses at 75°C, with tap position in plus (+) extreme tap position and at rated current of that position                                                           | kW                   | Insert                               |            |
|        | c. On-load losses at 75°C, with tap position in minus (-) extreme tap position and at rated current of that position                                                          | kW                   | Insert                               |            |
|        | d. average on load losses (this value will be evaluated)                                                                                                                      | kW                   | (a+b+c)/3                            |            |
| 3.4.5  | On-load losses capitalized value                                                                                                                                              | BDT/kW               | As per vol 1 of tender doc           |            |
| 3.4.6  | Tolerance to be applied to on-load losses in % on the guaranteed value                                                                                                        | %                    | 10                                   |            |
| 3.5    | Ancillary equipment (fans, pumps, heaters, etc.)                                                                                                                              |                      |                                      |            |
| 3.5.1  | Load of ancillary equipment <u>(this value will be evaluated)</u>                                                                                                             | kW                   | Insert                               |            |
| 3.5.2  | Capitalized valued of ancillary equipment load                                                                                                                                | BDT/kW               | As per vol 1 of tender doc           |            |
| 3.5.3  | Tolerance to be applied to ancillary equipment load in % of the guaranteed value                                                                                              | %                    | 20                                   |            |
| 3.6    | Insulation level                                                                                                                                                              |                      |                                      |            |
| 3.6.1  | High voltage (HV)                                                                                                                                                             |                      | LI 1425 SI1050                       |            |
| 3.6.2  | Medium voltage (MV)                                                                                                                                                           |                      | LI 1050 AC 460                       |            |
| 3.6.3  | Neutral                                                                                                                                                                       |                      | LI 170 AC 70                         |            |
| 3.6.4  | Low voltage (LV)                                                                                                                                                              |                      | LI 170 AC 70                         |            |
| 3.7    | The highest voltage for equipment (effective value)                                                                                                                           |                      |                                      |            |
| 3.7.1  | High voltage (HV)                                                                                                                                                             | kV                   | 420                                  |            |
| 3.7.2  | Medium voltage (MV)                                                                                                                                                           | kV                   | 245                                  |            |
| 3.7.3  | Neutral                                                                                                                                                                       | kV                   | 36                                   |            |
| 3.7.4  | Low voltage (LV)                                                                                                                                                              | kV                   | 36                                   |            |
| 3.8    | Rated insulation level                                                                                                                                                        |                      |                                      |            |
| 3.8.1  | Induced voltage (ACSD, ACLD)                                                                                                                                                  | kV                   | In acc. to IEC 60076-3               |            |
| 3.9    | Efficiencies                                                                                                                                                                  |                      |                                      |            |
| 3.9.1  | If $\cos\phi = 1.0$ and:<br>• 25 % load of the rated value<br>• 50 % load of the rated value<br>• 75 % load of the rated value<br>• 100 % load of the rated value             |                      | Insert<br>Insert<br>Insert<br>Insert |            |
| 3.9.2  | If $\cos\phi = 0.8$ (inductive) and:<br>• 25 % load of the rated value<br>• 50 % load of the rated value<br>• 75 % load of the rated value<br>• 100 % load of the rated value |                      | Insert<br>Insert<br>Insert<br>Insert |            |
| 3.10   | Voltage drop at the terminals of secondary winding at rated temperature and at the middle tap changer position                                                                |                      |                                      |            |
| 3.10.1 | • $\cos\phi = 1.00$                                                                                                                                                           |                      | Insert                               |            |
| 3.10.2 | • $\cos\phi = 0.95$ (inductive)                                                                                                                                               |                      | Insert                               |            |

|          |                                                                                                                                                                                                                                                                                                                                                                                                       |          |                            |  |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------------------|--|
| 3.10.3   | • $\cos\phi = 0.90$ (inductive)                                                                                                                                                                                                                                                                                                                                                                       |          | Insert                     |  |
| 3.10.4   | $\cos\phi = 0.80$ (inductive)                                                                                                                                                                                                                                                                                                                                                                         |          | Insert                     |  |
| 3.11     | No-load current at rated frequency                                                                                                                                                                                                                                                                                                                                                                    |          |                            |  |
| 3.11.1   | At $0.90 U_n$                                                                                                                                                                                                                                                                                                                                                                                         |          | Insert                     |  |
| 3.11.2   | At $1.00 U_n$                                                                                                                                                                                                                                                                                                                                                                                         |          | Insert                     |  |
| 3.11.3   | At $1.05 U_n$                                                                                                                                                                                                                                                                                                                                                                                         |          | Insert                     |  |
| 3.12     | Temperature rise limits, at rated power, with complete cooling system in service and at lowest volt-age tap                                                                                                                                                                                                                                                                                           |          |                            |  |
| 3.12.1   | Top oil                                                                                                                                                                                                                                                                                                                                                                                               | K        | $\leq 50$                  |  |
| 3.12.2   | Winding                                                                                                                                                                                                                                                                                                                                                                                               | K        | $\leq 55$                  |  |
| 3.12.3   | Hottest spot                                                                                                                                                                                                                                                                                                                                                                                          | K        | $\leq 65$                  |  |
| 3.13     | At the emergency cases it is allowed: <ul style="list-style-type: none"> <li>Continuous overload at the highestwinding temperature which exceeds by <math>2.5^\circ\text{C}</math> the guaranteed limit value</li> <li>Continuous voltage increase when the top oil temperature exceeds the guaranteed limit by <math>2.5^\circ\text{C}</math> at rated power (in % of the rated volt-age)</li> </ul> | MVA<br>% | Compliant to IEC 60076-7   |  |
| 3.14     | Guaranteed value of overloads in % of the rated power                                                                                                                                                                                                                                                                                                                                                 |          |                            |  |
| 3.14.1   | Normal overloads prediction which can occur once a day (in % of the rated power) within the winding temperature rise limit of $75^\circ\text{C}$                                                                                                                                                                                                                                                      |          |                            |  |
| 3.14.1.1 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                                                                           |          | InsertInsertInsert         |  |
| 3.14.1.2 | After operation under 20 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                                                                           |          | Insert<br>InsertInsert     |  |
| 3.14.1.3 | After operation under 120 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                                                                          |          | Insert<br>Insert<br>Insert |  |
| 3.14.2   | Sudden transient overloads (in % of the rated power) with the winding temperature rise limit of $85^\circ\text{C}$                                                                                                                                                                                                                                                                                    |          |                            |  |
| 3.14.2.1 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                                                                           |          | Insert<br>Insert<br>Insert |  |
| 3.14.2.2 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                                                                           |          | InsertInsertInsert         |  |
| 3.14.2.3 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                                                                           |          | Insert<br>InsertInsert     |  |

| No.      | Description                                                                                                                                                                                                                                                                                                                                                 | Minimum Requirements |                                | Guaranteed |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------|------------|
|          |                                                                                                                                                                                                                                                                                                                                                             | Unit                 | Data                           |            |
| 3.15     | Guaranteed values of loads at ambient temperature of 40°C, without danger of exceeding the oil and winding temperature limits: <ul style="list-style-type: none"> <li>with all cooling groups in operation (excluding stand-by cooling group)</li> <li>with one cooling group out of operation</li> <li>with two cooling groups out of operation</li> </ul> |                      | Insert<br><br>Insert<br>Insert |            |
| <b>4</b> | <b>Oil</b>                                                                                                                                                                                                                                                                                                                                                  |                      |                                |            |
| 4.1      | New                                                                                                                                                                                                                                                                                                                                                         |                      | Insert                         |            |
| 4.2      | Manufacturer                                                                                                                                                                                                                                                                                                                                                |                      | Insert                         |            |
| 4.3      | Type                                                                                                                                                                                                                                                                                                                                                        |                      | Insert                         |            |
| 4.4      | Standard                                                                                                                                                                                                                                                                                                                                                    |                      | IEC 60296                      |            |
| 4.5      | Minimum flash point                                                                                                                                                                                                                                                                                                                                         | °C                   | Insert                         |            |
| 4.6      | Viscosity at 20°C                                                                                                                                                                                                                                                                                                                                           | mm <sup>2</sup> /s   | Insert                         |            |
| 4.7      | Maximum dielectric strength                                                                                                                                                                                                                                                                                                                                 | kV/cm                | Insert                         |            |
| 4.8      | Data sheet attached                                                                                                                                                                                                                                                                                                                                         |                      | Insert                         |            |
| 4.9      | Corrosive Sulphur                                                                                                                                                                                                                                                                                                                                           |                      | <b>Non-Corrosive</b>           |            |
| 4.10     | PCB content                                                                                                                                                                                                                                                                                                                                                 |                      | <b>Without PCB</b>             |            |
| <b>5</b> | <b>Bushing</b>                                                                                                                                                                                                                                                                                                                                              |                      |                                |            |
| 5.1      | HV bushing                                                                                                                                                                                                                                                                                                                                                  |                      |                                |            |
| 5.1.1    | Quantity                                                                                                                                                                                                                                                                                                                                                    |                      | 3                              |            |
| 5.1.2    | Class                                                                                                                                                                                                                                                                                                                                                       | kV                   | 420                            |            |
| 5.1.3    | Manufacturer                                                                                                                                                                                                                                                                                                                                                |                      | Insert                         |            |
| 5.1.4    | Type                                                                                                                                                                                                                                                                                                                                                        |                      | Insert                         |            |
| 5.1.5    | Rated current                                                                                                                                                                                                                                                                                                                                               | A                    | ≥ 1000                         |            |
| 5.1.6    | Rated short circuit current (2 s)                                                                                                                                                                                                                                                                                                                           | kA rms               | 63                             |            |
| 5.1.7    | Rated lightning impulse withstand voltage                                                                                                                                                                                                                                                                                                                   | kV peak              | 1425                           |            |
| 5.1.8    | Rated switching impulse withstand voltage                                                                                                                                                                                                                                                                                                                   | kV peak              | 1050                           |            |
| 5.1.9    | Rated power frequency withstand voltage                                                                                                                                                                                                                                                                                                                     | kV rms               | 650                            |            |
| 5.1.10   | Connectors                                                                                                                                                                                                                                                                                                                                                  |                      |                                |            |
| 5.1.10.1 | Shape                                                                                                                                                                                                                                                                                                                                                       | mm                   | Ø 50                           |            |
| 5.1.10.2 | Length                                                                                                                                                                                                                                                                                                                                                      | mm                   | 125                            |            |
| 5.1.10.3 | Suitable for                                                                                                                                                                                                                                                                                                                                                |                      | Al wire                        |            |
| 5.1.11   | Minimum creepage distance (25 mm/kV)                                                                                                                                                                                                                                                                                                                        | mm/kV                | ≥ 25 mm/kV                     |            |
| 5.1.12   | Full vacuum withstand of complete bushing                                                                                                                                                                                                                                                                                                                   |                      | YES                            |            |
| 5.2      | Neutral bushing (identical as LV bushing)                                                                                                                                                                                                                                                                                                                   |                      |                                |            |
| 5.2.1    | Quantity                                                                                                                                                                                                                                                                                                                                                    |                      | 1                              |            |
| 5.2.2    | Class                                                                                                                                                                                                                                                                                                                                                       | kV                   | 52                             |            |
| 5.2.3    | Manufacturer                                                                                                                                                                                                                                                                                                                                                |                      | Insert                         |            |
| 5.2.4    | Type                                                                                                                                                                                                                                                                                                                                                        |                      | Insert                         |            |
| 5.2.5    | Rated current                                                                                                                                                                                                                                                                                                                                               | A                    | ≥ 2000                         |            |
| 5.2.6    | Rated short-circuit current (2 s)                                                                                                                                                                                                                                                                                                                           | kA rms               | 50                             |            |
| 5.2.7    | Rated lightning impulse withstand voltage                                                                                                                                                                                                                                                                                                                   | kV peak              | 250                            |            |
| 5.2.8    | Rated switching impulse withstand voltage                                                                                                                                                                                                                                                                                                                   | kV peak              | -                              |            |
| 5.2.9    | Rated power frequency withstand voltage                                                                                                                                                                                                                                                                                                                     | kV rms               | 95                             |            |
| 5.2.10   | Connectors                                                                                                                                                                                                                                                                                                                                                  |                      |                                |            |
| 5.2.10.1 | Shape                                                                                                                                                                                                                                                                                                                                                       | mm                   | Flat                           |            |

| No.      | Description                                           | Minimum Requirements |                  | Guaranteed |
|----------|-------------------------------------------------------|----------------------|------------------|------------|
|          |                                                       | Unit                 | Data             |            |
| 5.2.10.2 | Length                                                | mm                   | -                |            |
| 5.2.10.3 | Suitable for                                          |                      | Cu wire          |            |
| 5.2.11   | Minimum creepage distance (25 mm/kV)                  | mm/kV                | $\geq 25$ mm/kV  |            |
| 5.2.12   | Full vacuum withstand of complete bushing             |                      | YES              |            |
| 5.3      | MV bushings                                           |                      |                  |            |
| 5.3.1    | Quantity                                              |                      | 3                |            |
| 5.3.2    | Class                                                 | kV                   | 245              |            |
| 5.3.3    | Manufacturer                                          |                      | Insert           |            |
| 5.3.4    | Type                                                  |                      | Insert           |            |
| 5.3.5    | Rated current                                         | A                    | $\geq 1600$      |            |
| 5.3.6    | Rated short-circuit current (2 s)                     | kA rms               | 50               |            |
| 5.3.7    | Rated lightning impulse withstand voltage             | kV peak              | 1050             |            |
| 5.3.8    | Rated switching impulse withstand voltage             | kV peak              | -                |            |
| 5.3.9    | Rated power frequency withstand voltage               | kV rms               | 460              |            |
| 5.3.10   | Connectors                                            |                      |                  |            |
| 5.3.10.1 | Shape                                                 | mm                   | Ø 50             |            |
| 5.3.10.2 | Length                                                | mm                   | 125              |            |
| 5.3.10.3 | Suitable for                                          |                      | Al wire          |            |
| 5.3.11   | Minimum creepage distance (25 mm/kV)                  | mm/kV                | $\geq 25$ mm/kV  |            |
| 5.3.12   | Full vacuum withstand of complete bushing             |                      | YES              |            |
| 5.4      | LV bushings                                           |                      |                  |            |
| 5.4.1    | Quantity                                              |                      | 3                |            |
| 5.4.2    | Class                                                 | kV                   | 52               |            |
| 5.4.3    | Manufacturer                                          |                      | Insert           |            |
| 5.4.4    | Type                                                  |                      | Insert           |            |
| 5.4.5    | Rated current                                         | A                    | $\geq 2000$      |            |
| 5.4.6    | Rated short-circuit current (2 s)                     | kA rms               | 31.5             |            |
| 5.4.7    | Rated lightning impulse withstand voltage             | kV peak              | 250              |            |
| 5.4.8    | Rated switching impulse withstand voltage             | kV peak              | -                |            |
| 5.4.9    | Rated power frequency withstand voltage               | kV rms               | 95               |            |
| 5.4.10   | Connectors                                            |                      |                  |            |
| 5.4.10.1 | Shape                                                 | mm                   | Flat             |            |
| 5.4.10.2 | Length                                                | mm                   | -                |            |
| 5.4.10.3 | Adjusted for Cu wire                                  |                      | Cu wire          |            |
| 5.4.11   | Minimum creepage distance (25 mm/kV)                  | mm/kV                | $\geq 25$ mm/kV  |            |
| 5.4.12   | Full vacuum withstand of complete bushing             |                      | YES              |            |
| <b>6</b> | <b>Design Data</b>                                    |                      |                  |            |
| 6.1      | Maximum flux density in the legs                      |                      |                  |            |
|          | • At rated voltage<br>• At 105 % of the rated voltage | T<br>T               | Insert<br>Insert |            |
| 6.2      | Maximum flux density in the yokes:                    |                      |                  |            |
|          | • At rated voltage<br>• At 105 % of the rated voltage | T<br>T               | Insert<br>Insert |            |

| No.      | Description                                                                                                                                                                                      | Minimum Requirements                                        |                                                      | Guaranteed |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------|------------|
|          |                                                                                                                                                                                                  | Unit                                                        | Data                                                 |            |
| 6.3      | Maximum current density in windings at rated power and normal tap changer position:<br>• HV winding<br>• MV winding<br>• LV - stabilizing winding                                                | A/mm <sup>2</sup><br>A/mm <sup>2</sup><br>A/mm <sup>2</sup> | Insert<br>Insert<br>Insert                           |            |
| 6.4      | Winding resistance at 75°C and middle tap changer position:<br>• HV winding<br>• MV winding<br>• LV - stabilizing winding                                                                        | Ω<br>Ω<br>Ω                                                 | Insert<br>Insert<br>Insert                           |            |
| 6.5      | Core construction                                                                                                                                                                                |                                                             |                                                      |            |
| 6.5.1    | Method of joining of legs                                                                                                                                                                        |                                                             | Insert                                               |            |
| 6.5.2    | Method of joining of yokes                                                                                                                                                                       |                                                             | Insert                                               |            |
| 6.5.3    | Joining material                                                                                                                                                                                 |                                                             | Insert                                               |            |
| 6.5.4    | Number of legs                                                                                                                                                                                   |                                                             | Insert                                               |            |
| 6.5.5    | Type of core steel                                                                                                                                                                               |                                                             | Insert                                               |            |
| 6.5.6    | Specific loss of core steel at 1.7 T inductance                                                                                                                                                  | W/kg                                                        | < 1.11                                               |            |
| 6.6      | Winding conductor                                                                                                                                                                                |                                                             |                                                      |            |
| 6.6.1    | HV winding                                                                                                                                                                                       |                                                             | Cu - Interleaved & Continuous                        |            |
| 6.6.2    | MV winding                                                                                                                                                                                       |                                                             | Cu - Continuous                                      |            |
| 6.6.3    | LV - stabilizing winding                                                                                                                                                                         |                                                             | Cu - Helical                                         |            |
| 6.7      | Audible noise level (acc. to NEMA TR1), at 105 % of rated voltage, at maximum power and with complete cooling system in service                                                                  | dB                                                          | Insert                                               |            |
| 6.8      | Radio Interference Voltage at 0.5 MHz as specified in IEC 60694                                                                                                                                  | μV                                                          | 2500 max                                             |            |
| <b>7</b> | <b>Weights and dimensions</b>                                                                                                                                                                    |                                                             |                                                      |            |
| 7.1      | Total weight of autotransformer, equipped for service                                                                                                                                            | kg                                                          | less or equals to attached GA value*                 |            |
| 7.2      | Core and oil assembly                                                                                                                                                                            | kg                                                          | insert*                                              |            |
| 7.3      | Total mass excluding oil                                                                                                                                                                         | kg                                                          | insert*                                              |            |
| 7.4      | Tank and accessories                                                                                                                                                                             | kg                                                          | insert*                                              |            |
| 7.5      | Oil mass in tank                                                                                                                                                                                 | kg                                                          | insert*                                              |            |
| 7.6      | Oil mass in coolers                                                                                                                                                                              | kg                                                          | insert*                                              |            |
| 7.7      | Oil mass total                                                                                                                                                                                   | kg                                                          | insert*                                              |            |
| 7.8      | Total mass                                                                                                                                                                                       | kg                                                          | insert*                                              |            |
| 7.9      | Maximum shipping weight (the heaviest item)                                                                                                                                                      | kg                                                          | insert*                                              |            |
| 7.10     | Height from foundation to:<br>• Highest point of HV bushing<br>• Highest point of tank<br>• Highest point of conservator<br>• Highest point of lifting hook for removal of core and oil assembly | mm<br>mm<br>mm<br>mm                                        | As per GA*<br>As per GA*<br>As per GA*<br>As per GA* |            |

| No.       | Description                                                                                     | Minimum Requirements |                                                                         | Guaranteed |
|-----------|-------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------------------------------|------------|
|           |                                                                                                 | Unit                 | Data                                                                    |            |
| 7.11      | Outer dimensions:<br>• Length<br>• Width                                                        | mm<br>mm             | As per GA*<br>As per GA*                                                |            |
| 7.12      | Informative dimensional sketch                                                                  |                      | To be enclosed with bid                                                 |            |
| 7.13      | Maximum shipping dimensions of tank:<br>• Outside height<br>• Outside width<br>• Outside length | mm<br>mm<br>mm       | insert                                                                  |            |
| 7.14      | Transportation drawing                                                                          |                      | To be enclosed with bid                                                 |            |
| <b>8</b>  | <b>Tap changer</b>                                                                              |                      |                                                                         |            |
| 8.1       | Manufacturer                                                                                    |                      | Insert                                                                  |            |
| 8.2       | Type                                                                                            |                      | Insert                                                                  |            |
| 8.3       | Insulation level                                                                                | kV                   | Li 1050                                                                 |            |
| 8.4       | Rated current                                                                                   | A                    | ≥ 1000                                                                  |            |
| 8.5       | Number of steps                                                                                 |                      | 17                                                                      |            |
| 8.6       | Regulating coil                                                                                 |                      | At auto point                                                           |            |
| 8.7       | Short-circuit withstand                                                                         | kA rms               | Insert                                                                  |            |
| 8.8       | BIL to ground through the regulating coil                                                       | kV peak              | Insert                                                                  |            |
| 8.9       | Power frequency withstand voltage for 1 minute through the regulating coil                      | kV rms               | Insert                                                                  |            |
| 8.10      | Tap position indicator                                                                          |                      | Digital code matrix (BCD)                                               |            |
| 8.11      | Auxiliary supply                                                                                |                      | 3x400 V / 230 V, 50 Hz                                                  |            |
| 8.12      | Type of control                                                                                 |                      | On load local, remote and supervisory electrical and hand operation     |            |
| <b>9</b>  | <b>Auxiliary power supply</b>                                                                   |                      |                                                                         |            |
| 9.1       | Motors                                                                                          |                      | 3x400 V / 50 Hz                                                         |            |
| 9.2       | Heaters                                                                                         |                      | 230 V / 50 Hz                                                           |            |
| 9.3       | Control voltage                                                                                 |                      | 110 V DC                                                                |            |
| 9.4       | Oil pump                                                                                        |                      | 3x400 V / 50 Hz                                                         |            |
| <b>10</b> | <b>Current transformer incorporated into the power autotransformer</b>                          |                      |                                                                         |            |
| 10.1      | CT in HV bushings, for protection, WTI and/or Tap Changer                                       |                      | In all phases, 3 cores characteristics shall be defined in design stage |            |
| 10.2      | CT in MV bushings, for protection, WTI and/or Tap Changer                                       |                      | In all phases, 3 cores characteristics shall be defined in design stage |            |
| 10.3      | CT in neutral bushing , for protection                                                          |                      | In all phases, 3cores characteristics shall be defined in design stage  |            |
| 10.4      | CT in LV bushings, for protection                                                               |                      | In all phases, 3 cores characteristics shall be defined in design stage |            |
| <b>11</b> | <b>Layout</b>                                                                                   |                      |                                                                         |            |
| 11.1      | Primary winding bushings                                                                        |                      | Longitudinal axis                                                       |            |
| 11.2      | Secondary winding bushings                                                                      |                      | Longitudinal axis (opposite to HV)                                      |            |

| No.       | Description                                                                                                                             | Minimum Requirements |                                                                        | Guaranteed |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------------------------------------------|------------|
|           |                                                                                                                                         | Unit                 | Data                                                                   |            |
| 11.3      | Conservator tank                                                                                                                        |                      | To be defined in design stage                                          |            |
| 11.4      | Tap changer                                                                                                                             |                      | To be defined in design stage                                          |            |
| 11.5      | Control cabinet                                                                                                                         |                      | To be defined in design stage                                          |            |
| 11.6      | Coolers                                                                                                                                 |                      | To be defined in design stage                                          |            |
| 11.7      | Connection drawing, block diagram                                                                                                       |                      | To be enclosed with bid                                                |            |
| <b>12</b> | <b>Cooling groups</b>                                                                                                                   |                      |                                                                        |            |
| 12.1      | Number of cooling groups (total)                                                                                                        | Qty.                 | 4                                                                      |            |
| 12.2      | Number of cooling groups (for rated power)                                                                                              | Qty.                 | 3                                                                      |            |
| 12.3      | Number of stand-by cooling groups                                                                                                       | Qty.                 | One fan in each group with failing of one fan shall not reduce the MCR |            |
| 12.4      | Number of coolers in a cooling group                                                                                                    | Qty.                 | Insert                                                                 |            |
| 12.5      | Number of spare fans                                                                                                                    | Qty.                 | Insert                                                                 |            |
| 12.6      | Rating of each cooler                                                                                                                   | kW                   | Insert                                                                 |            |
| 12.7      | Power factor of the fan motor of each fan                                                                                               |                      |                                                                        |            |
| 12.8      | Full vacuum withstand of complete cooler                                                                                                | mbar                 | Yes                                                                    |            |
| <b>13</b> | <b>Dehydrating breather</b>                                                                                                             |                      |                                                                        |            |
| 13.1      | Type of dehydrating breather                                                                                                            |                      | Insert                                                                 |            |
| 13.2      | Dehumidifying agent                                                                                                                     | kg                   | Insert                                                                 |            |
| <b>14</b> | <b>Autotransformer tank</b>                                                                                                             |                      |                                                                        |            |
| 14.1      | Type of design                                                                                                                          |                      |                                                                        |            |
| 14.2      | Thickness of transformer tank:<br>• Sides<br>• Bottom<br>• Top                                                                          | mm<br>mm<br>mm       | Insert<br>Insert<br>Insert                                             |            |
| 14.3      | Material of the autotransformer tank                                                                                                    |                      | Insert                                                                 |            |
| 14.4      | Wheels                                                                                                                                  |                      |                                                                        |            |
| 14.4.1    | Wheel number for each rail of two pair rails                                                                                            |                      | Two pairs                                                              |            |
| 14.4.2    | Axial inter space in transversal direction between two pairs of rails                                                                   | mm                   | insert                                                                 |            |
| 14.4.3    | Transversal distance between wheels in pair                                                                                             | mm                   | insert                                                                 |            |
| 14.4.4    | Distance between wheels in longitudinal direction                                                                                       | mm                   | insert                                                                 |            |
| 14.5      | Corrosion protection of the tank                                                                                                        |                      | YES                                                                    |            |
| 14.6      | Vacuum withstand of the complete tank with cooler                                                                                       | mbar                 | insert                                                                 |            |
| 14.7      | Over-pressure withstand of the complete auto-transformer                                                                                | bar                  | insert                                                                 |            |
| <b>15</b> | <b>Conservator</b>                                                                                                                      |                      |                                                                        |            |
| 15.1      | Type                                                                                                                                    |                      | With diaphragm                                                         |            |
| 15.2      | Number of compartments                                                                                                                  | pcs.                 | 2                                                                      |            |
| 15.3      | Total volume of conservator                                                                                                             | m <sup>3</sup>       | Insert                                                                 |            |
| 15.4      | Minimum volume of conservator between highest and lowest levels as percentage of total cold oil at 0°C of the volume of autotransformer | %                    | Insert                                                                 |            |

| No.       | Description                                                                                                                                                                                                 | Minimum Requirements |                            | Guaranteed |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------|------------|
|           |                                                                                                                                                                                                             | Unit                 | Data                       |            |
| 15.5      | Pressure rise inside the tank due to oil expansion                                                                                                                                                          |                      | Insert                     |            |
| 15.6      | Diagraph design parameters: <ul style="list-style-type: none"> <li>Maximum diagraph stress at highest working pressure</li> <li>Diagraph construction details</li> <li>Type of diagraph material</li> </ul> |                      | Insert<br>Insert<br>Insert |            |
| 15.7      | Corrosion protection of conservator                                                                                                                                                                         |                      | Insert                     |            |
| 15.8      | Oil level indicators with alarm for minimum oil level                                                                                                                                                       | pcs.                 | 2                          |            |
| <b>16</b> | <b>Operating conditions</b>                                                                                                                                                                                 |                      |                            |            |
| 16.1      | At the altitude (above sea level)                                                                                                                                                                           | m                    | ≤ 1000                     |            |
| 16.2      | Maximum ambient temperature                                                                                                                                                                                 | °C                   | + 45                       |            |
| 16.3      | Average daily temperature                                                                                                                                                                                   | °C                   | + 35                       |            |
| 16.4      | Average annual temperature                                                                                                                                                                                  | °C                   | + 30                       |            |
| 16.5      | Minimum ambient temperature                                                                                                                                                                                 | °C                   | – 5                        |            |
| 16.6      | Tertiary winding                                                                                                                                                                                            |                      | Will be used               |            |
| 16.7      | Parallel operation                                                                                                                                                                                          |                      | Yes                        |            |
|           | <b>Overall compliance with the requirements (yes/no)</b>                                                                                                                                                    |                      |                            |            |

\* Guaranteed values subject to deduction from Contract Price

\*\*These values are required for Foundation design & shipping purpose only. During detail design, these values may vary from Bid value due to attaining desired electrical output.

**2.2 230/132/33 kV, 225/300MVA, 3-PHASE POWER TRANSFORMER:**

| No. | Description                                                                                 | Minimum Requirements |                                                                                                                                       | Guaranteed |
|-----|---------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------|
|     |                                                                                             | Unit                 | Data                                                                                                                                  |            |
| 1   | General                                                                                     |                      |                                                                                                                                       |            |
| 1.1 | Manufacturer                                                                                |                      | Insert                                                                                                                                |            |
| 1.2 | Type                                                                                        |                      | Autotransformer three-phase, oil immersed, with tertiary winding, hermetically sealed, with on-load tap changer, outdoor              |            |
| 1.3 | Model designation                                                                           |                      | Insert                                                                                                                                |            |
| 1.4 | Country of origin                                                                           |                      | Insert                                                                                                                                |            |
| 1.5 | Standards                                                                                   |                      | IEC 60044<br>IEC 60076<br>IEC 60137<br>IEC 60214<br>IEC 60354<br>IEC 60529<br>IEC 60815<br>IEC 60947<br>NEMA TR-1<br>CENELEC EN 50216 |            |
| 1.6 | Quality control                                                                             |                      | ISO 9001                                                                                                                              |            |
| 1.7 | Tertiary winding function                                                                   |                      | Stabilizing winding & auxiliary power supply                                                                                          |            |
| 1.8 | Thermal insulation class                                                                    |                      | A                                                                                                                                     |            |
| 2   | Ratings and properties                                                                      |                      |                                                                                                                                       |            |
| 2.1 | Rated power:<br>• Primary / secondary winding<br>• Tertiary - minimum                       | MVA<br>MVA           | 300 / 300<br>≥ 100                                                                                                                    |            |
| 2.2 | Rated power by cooling ONAN / ONAF<br>• Primary / secondary winding<br>• Tertiary - minimum | MVA<br>MVA           | 225 / 300<br>≥ 75 / ≥ 100                                                                                                             |            |
| 2.3 | Rated voltage of windings:<br>• HV winding<br>• MV winding<br>• LV - stabilizing winding    | kV<br>kV<br>kV       | 230<br>132<br>33                                                                                                                      |            |
| 2.4 | Tap changer:                                                                                |                      |                                                                                                                                       |            |
|     | • Manufacturer                                                                              |                      | Insert                                                                                                                                |            |
|     | • Country of origin                                                                         |                      | Insert                                                                                                                                |            |
|     | • Model designation                                                                         |                      | insert                                                                                                                                |            |
|     | • Type of tap changing                                                                      |                      | On-load                                                                                                                               |            |
|     | • Tap changer location                                                                      |                      | At High voltage side                                                                                                                  |            |
|     | • Type of voltage regulation                                                                | %                    | C.F.V.V.                                                                                                                              |            |
|     | • Tapping range                                                                             | %                    | ±10                                                                                                                                   |            |
|     |                                                                                             |                      |                                                                                                                                       |            |
|     | Tapping step                                                                                |                      | 1.25                                                                                                                                  |            |
|     | Rating                                                                                      |                      | Rated power 300 MVA,all taps                                                                                                          |            |
| 2.5 | Frequency                                                                                   | Hz                   | 50                                                                                                                                    |            |
| 2.6 | Connection of three-phase windings (group of vector IEC 60076)                              |                      | YNad1                                                                                                                                 |            |

| No.      | Description                                                                                                                                                                                     | Minimum Requirements   |                                                                    | Guaranteed |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------|------------|
|          |                                                                                                                                                                                                 | Unit                   | Data                                                               |            |
| 2.7      | Neutral point insulation                                                                                                                                                                        |                        | Li95                                                               |            |
| 2.8      | Low voltage winding connection (LV)                                                                                                                                                             |                        | closed delta, with three terminals brought out outside of the tank |            |
| 2.9      | Type of oil preservation system                                                                                                                                                                 |                        | Air Cell                                                           |            |
| 2.10     | Maximum acceptable noise level                                                                                                                                                                  |                        | 78dB                                                               |            |
| <b>3</b> | <b>Special technical requirements</b>                                                                                                                                                           |                        |                                                                    |            |
| 3.1      | Short circuit impedance corrected to reference temperature of 75°C at rated frequency and rated power                                                                                           |                        |                                                                    |            |
| 3.1.1    | HV - MV, on the basis of rated power with on-load tap changer in middle position                                                                                                                | %                      | <b>13 ±10 %</b>                                                    |            |
| 3.1.2    | HV - LV, on the basis of rated power with on-load tap changer in middle position                                                                                                                | %                      | Insert                                                             |            |
| 3.1.3    | MV - LV, on the basis of rated power 'x' MVA with on-load tap changer in middle position                                                                                                        | %                      | Insert                                                             |            |
| 3.2      | Zero-sequence impedance, with tap changer in middle position:<br>• HV/MV<br>• HV/LV<br>• MV/LV                                                                                                  | %<br>%<br>%            | Insert<br>Insert<br>Insert                                         |            |
| 3.3      | Autotransformer capacity to withstand external short circuits                                                                                                                                   |                        |                                                                    |            |
| 3.3.1    | Short-circuit duration                                                                                                                                                                          | s                      | 2                                                                  |            |
| 3.3.2    | Symmetrical short-circuit with-stand capacity and asymmetrical short-circuit withstand capacity during indicated period:<br>• HV winding<br>• MV winding<br>• LV winding<br>• Pre-fault voltage | kA<br>kA<br>kA<br>p.u. | 50<br>40<br>31.5<br>1.05                                           |            |
| 3.4      | Guaranteed losses                                                                                                                                                                               |                        |                                                                    |            |
| 3.4.1    | a. No-load losses with tap changer in nominal tap position:<br>at rated voltage and rated frequency                                                                                             | kW                     | <b>Insert</b>                                                      |            |
|          | b. No-load losses with tap changer in nominal tap position at 110% rated voltage and rated frequency                                                                                            | kW                     | <b>Insert</b>                                                      |            |
|          | c. No-load losses with tap changer in nominal tap position at 90% rated voltage, at rated frequency                                                                                             | kW                     | Insert                                                             |            |
|          | d. average no load loss (this value will be evaluated)                                                                                                                                          | kW                     | <b>(a+b+c)/3</b>                                                   |            |
| 3.4.2    | No-load losses capitalized value                                                                                                                                                                | BDT/kW                 | <b>As per vol 1 of tender doc</b>                                  |            |
| 3.4.3    | Tolerance to be applied to no-load losses in % of the guaranteed value                                                                                                                          | %                      | 10                                                                 |            |

| No.    | Description                                                                                                                                                                   | Minimum Requirements |                                      | Guaranteed |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------|------------|
|        |                                                                                                                                                                               | Unit                 | Data                                 |            |
| 3.4.4  | a. On-load losses at 75°C, with tap changer in nominal position and at rated current of that tap position                                                                     | kW                   | Insert                               |            |
|        | b. On-load losses at 75°C, with tap position in plus (+) extreme tap position and at rated current of that position                                                           | kW                   | Insert                               |            |
|        | c. On-load losses at 75°C, with tap position in minus (-) extreme tap position and at rated current of that position                                                          | kW                   | Insert                               |            |
|        | d. average on load losses (this value will be evaluated)                                                                                                                      | kW                   | (a+b+c)/3                            |            |
| 3.4.5  | On-load losses capitalized value                                                                                                                                              | BDT/kW               | As per vol 1 of tender doc           |            |
| 3.4.6  | Tolerance to be applied to on-load losses in % on the guaranteed value                                                                                                        | %                    | 10                                   |            |
| 3.5    | Ancillary equipment (fans, pumps, heaters, etc.)                                                                                                                              |                      |                                      |            |
| 3.5.1  | Load of ancillary equipment <u>(this value will be evaluated)</u>                                                                                                             | kW                   | Insert                               |            |
| 3.5.2  | Capitalized valued of ancillary equipment load                                                                                                                                | BDT/kW               | As per vol 1 of tender doc           |            |
| 3.5.3  | Tolerance to be applied to ancillary equipment load in % of the guaranteed value                                                                                              | %                    | 20                                   |            |
| 3.6    | Insulation level                                                                                                                                                              |                      |                                      |            |
| 3.6.1  | High voltage (HV)                                                                                                                                                             |                      | LI 1050 AC460                        |            |
| 3.6.2  | Medium voltage (MV)                                                                                                                                                           |                      | LI 650 AC 275                        |            |
| 3.6.3  | Neutral                                                                                                                                                                       |                      | LI 95 AC 38                          |            |
| 3.6.4  | Low voltage (LV)                                                                                                                                                              |                      | LI 170 AC 70                         |            |
| 3.7    | The highest voltage for equipment (effective value)                                                                                                                           |                      |                                      |            |
| 3.7.1  | High voltage (HV)                                                                                                                                                             | kV                   | 245                                  |            |
| 3.7.2  | Medium voltage (MV)                                                                                                                                                           | kV                   | 145                                  |            |
| 3.7.3  | Neutral                                                                                                                                                                       | kV                   | 36                                   |            |
| 3.7.4  | Low voltage (LV)                                                                                                                                                              | kV                   | 36                                   |            |
| 3.8    | Rated insulation level                                                                                                                                                        |                      |                                      |            |
| 3.8.1  | Induced voltage (ACSD, ACLD)                                                                                                                                                  | kV                   | In acc. to IEC 60076-3               |            |
| 3.9    | Efficiencies                                                                                                                                                                  |                      |                                      |            |
| 3.9.1  | If $\cos\phi = 1.0$ and:<br>• 25 % load of the rated value<br>• 50 % load of the rated value<br>• 75 % load of the rated value<br>• 100 % load of the rated value             |                      | Insert<br>Insert<br>Insert<br>Insert |            |
| 3.9.2  | If $\cos\phi = 0.8$ (inductive) and:<br>• 25 % load of the rated value<br>• 50 % load of the rated value<br>• 75 % load of the rated value<br>• 100 % load of the rated value |                      | Insert<br>Insert<br>Insert<br>Insert |            |
| 3.10   | Voltage drop at the terminals of secondary winding at rated temperature and at the middle tap changer position                                                                |                      |                                      |            |
| 3.10.1 | • $\cos\phi = 1.00$                                                                                                                                                           |                      | Insert                               |            |
| 3.10.2 | • $\cos\phi = 0.95$ (inductive)                                                                                                                                               |                      | Insert                               |            |
| 3.10.3 | • $\cos\phi = 0.90$ (inductive)                                                                                                                                               |                      | Insert                               |            |

| No.      | Description                                                                                                                                                                                                                                                                                                                                         | Minimum Requirements |                            | Guaranteed |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------|------------|
|          |                                                                                                                                                                                                                                                                                                                                                     | Unit                 | Data                       |            |
| 3.10.4   | $\cos\phi = 0.80$ (inductive)                                                                                                                                                                                                                                                                                                                       |                      | Insert                     |            |
| 3.11     | No-load current at rated frequency                                                                                                                                                                                                                                                                                                                  |                      |                            |            |
| 3.11.1   | At 0.90 $U_n$                                                                                                                                                                                                                                                                                                                                       |                      | Insert                     |            |
| 3.11.2   | At 1.00 $U_n$                                                                                                                                                                                                                                                                                                                                       |                      | Insert                     |            |
| 3.11.3   | At 1.05 $U_n$                                                                                                                                                                                                                                                                                                                                       |                      | Insert                     |            |
| 3.12     | Temperature rise limits, at rated power, with complete cooling system in service and at lowest voltage tap                                                                                                                                                                                                                                          |                      |                            |            |
| 3.12.1   | Top oil                                                                                                                                                                                                                                                                                                                                             | K                    | $\leq 50$                  |            |
| 3.12.2   | Winding                                                                                                                                                                                                                                                                                                                                             | K                    | $\leq 55$                  |            |
| 3.12.3   | Hottest spot                                                                                                                                                                                                                                                                                                                                        | K                    | $\leq 65$                  |            |
| 3.13     | At the emergency cases it is allowed: <ul style="list-style-type: none"> <li>Continuous overload at the highest winding temperature which exceeds by 2.5°C the guaranteed limit value</li> <li>Continuous voltage increase when the top oil temperature exceeds the guaranteed limit by 2.5°C at rated power (in % of the rated voltage)</li> </ul> | MVA<br>%             | Compliant to IEC 60076-7   |            |
| 3.14     | Guaranteed value of overloads in % of the rated power                                                                                                                                                                                                                                                                                               |                      |                            |            |
| 3.14.1   | Normal overloads prediction which can occur once a day (in % of the rated power) within the winding temperature rise limit of 75°C                                                                                                                                                                                                                  |                      |                            |            |
| 3.14.1.1 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                         |                      | Insert<br>Insert<br>Insert |            |
| 3.14.1.2 | After operation under 20 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                         |                      | Insert<br>Insert<br>Insert |            |
| 3.14.1.3 | After operation under 120 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                        |                      | Insert<br>Insert<br>Insert |            |
| 3.14.2   | Sudden transient overloads (in % of the rated power) with the winding temperature rise limit of 85°C                                                                                                                                                                                                                                                |                      |                            |            |
| 3.14.2.1 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                         |                      | Insert<br>Insert<br>Insert |            |
| 3.14.2.2 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                         |                      | Insert<br>Insert<br>Insert |            |
| 3.14.2.3 | After operation under 15 min <ul style="list-style-type: none"> <li>full rated power</li> <li><math>\frac{3}{4}</math> rated power</li> <li><math>\frac{1}{2}</math> rated power</li> </ul>                                                                                                                                                         |                      | Insert<br>Insert<br>Insert |            |

| No.      | Description                                                                                                                    | Minimum Requirements |                      | Guaranteed |
|----------|--------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|------------|
|          |                                                                                                                                | Unit                 | Data                 |            |
| 3.15     | Guaranteed values of loads at ambient temperature of 40°C, without danger of exceeding the oil and winding temperature limits: |                      |                      |            |
|          | • with all cooling groups in operation (excluding stand-by cooling group)                                                      |                      | Insert               |            |
|          | • with one cooling group out of operation                                                                                      |                      | Insert               |            |
|          | • with two cooling groups out of operation                                                                                     |                      | Insert               |            |
| <b>4</b> | <b>Oil</b>                                                                                                                     |                      |                      |            |
| 4.1      | New                                                                                                                            |                      | Insert               |            |
| 4.2      | Manufacturer                                                                                                                   |                      | Insert               |            |
| 4.3      | Type                                                                                                                           |                      | Insert               |            |
| 4.4      | Standard                                                                                                                       |                      | IEC 60296            |            |
| 4.5      | Minimum flash point                                                                                                            | °C                   | Insert               |            |
| 4.6      | Viscosity at 20°C                                                                                                              | mm <sup>2</sup> /s   | Insert               |            |
| 4.7      | Maximum dielectric strength                                                                                                    | kV/cm                | Insert               |            |
| 4.8      | Data sheet attached                                                                                                            |                      | Insert               |            |
| 4.9      | Corrosive Sulphur                                                                                                              |                      | <b>Non-Corrosive</b> |            |
| 4.10     | PCB content                                                                                                                    |                      | <b>Without PCB</b>   |            |
| <b>5</b> | <b>Bushing</b>                                                                                                                 |                      |                      |            |
| 5.1      | HV bushing                                                                                                                     |                      |                      |            |
| 5.1.1    | Quantity                                                                                                                       |                      | 3                    |            |
| 5.1.2    | Class                                                                                                                          | kV                   | 420                  |            |
| 5.1.3    | Manufacturer                                                                                                                   |                      | Insert               |            |
| 5.1.4    | Type                                                                                                                           |                      | Insert               |            |
| 5.1.5    | Rated current                                                                                                                  | A                    | ≥ 1000               |            |
| 5.1.6    | Rated short circuit current (2 s)                                                                                              | kA rms               | 50                   |            |
| 5.1.7    | Rated lightning impulse withstand voltage                                                                                      | kV peak              | 1050                 |            |
| 5.1.8    | Rated switching impulse withstand voltage                                                                                      | kV peak              |                      |            |
| 5.1.9    | Rated power frequency withstand voltage                                                                                        | kV rms               | 460                  |            |
| 5.1.10   | Connectors                                                                                                                     |                      |                      |            |
| 5.1.10.1 | Shape                                                                                                                          | mm                   | Ø 50                 |            |
| 5.1.10.2 | Length                                                                                                                         | mm                   | 125                  |            |
| 5.1.10.3 | Suitable for                                                                                                                   |                      | Al wire              |            |
| 5.1.11   | Minimum creepage distance (25 mm/kV)                                                                                           | mm/kV                | ≥ 25 mm/kV           |            |
| 5.1.12   | Full vacuum withstand of complete bushing                                                                                      |                      | YES                  |            |
| 5.2      | Neutral bushing (identical as LV bushing)                                                                                      |                      |                      |            |
| 5.2.1    | Quantity                                                                                                                       |                      | 1                    |            |
| 5.2.2    | Class                                                                                                                          | kV                   | 36                   |            |
| 5.2.3    | Manufacturer                                                                                                                   |                      | Insert               |            |
| 5.2.4    | Type                                                                                                                           |                      | Insert               |            |
| 5.2.5    | Rated current                                                                                                                  | A                    | ≥ 2000               |            |
| 5.2.6    | Rated short-circuit current (2 s)                                                                                              | kA rms               | 50                   |            |
| 5.2.7    | Rated lightning impulse withstand voltage                                                                                      | kV peak              | 170                  |            |
| 5.2.8    | Rated switching impulse withstand voltage                                                                                      | kV peak              | -                    |            |
| 5.2.9    | Rated power frequency withstand voltage                                                                                        | kV rms               | 70                   |            |
| 5.2.10   | Connectors                                                                                                                     |                      |                      |            |
| 5.2.10.1 | Shape                                                                                                                          | mm                   | Flat                 |            |

| No.      | Description                                                                                 | Minimum Requirements |                  | Guaranteed |
|----------|---------------------------------------------------------------------------------------------|----------------------|------------------|------------|
|          |                                                                                             | Unit                 | Data             |            |
| 5.2.10.2 | Length                                                                                      | mm                   | -                |            |
| 5.2.10.3 | Suitable for                                                                                |                      | Cu wire          |            |
| 5.2.11   | Minimum creepage distance (25 mm/kV)                                                        | mm/kV                | ≥ 25 mm/kV       |            |
| 5.2.12   | Full vacuum withstand of complete bushing                                                   |                      | YES              |            |
| 5.3      | MV bushings                                                                                 |                      |                  |            |
| 5.3.1    | Quantity                                                                                    |                      | 3                |            |
| 5.3.2    | Class                                                                                       | kV                   | 145              |            |
| 5.3.3    | Manufacturer                                                                                |                      | Insert           |            |
| 5.3.4    | Type                                                                                        |                      | Insert           |            |
| 5.3.5    | Rated current                                                                               | A                    | ≥ 1600           |            |
| 5.3.6    | Rated short-circuit current (2 s)                                                           | kA rms               | 40               |            |
| 5.3.7    | Rated lightning impulse withstand voltage                                                   | kV peak              | 650              |            |
| 5.3.8    | Rated switching impulse withstand voltage                                                   | kV peak              | -                |            |
| 5.3.9    | Rated power frequency withstand voltage                                                     | kV rms               | 275              |            |
| 5.3.10   | Connectors                                                                                  |                      |                  |            |
| 5.3.10.1 | Shape                                                                                       | mm                   | Ø 50             |            |
| 5.3.10.2 | Length                                                                                      | mm                   | 125              |            |
| 5.3.10.3 | Suitable for                                                                                |                      | Al wire          |            |
| 5.3.11   | Minimum creepage distance (25 mm/kV)                                                        | mm/kV                | ≥ 25 mm/kV       |            |
| 5.3.12   | Full vacuum withstand of complete bushing                                                   |                      | YES              |            |
| 5.4      | LV bushings                                                                                 |                      |                  |            |
| 5.4.1    | Quantity                                                                                    |                      | 4                |            |
| 5.4.2    | Class                                                                                       | kV                   | 36               |            |
| 5.4.3    | Manufacturer                                                                                |                      | Insert           |            |
| 5.4.4    | Type                                                                                        |                      | Insert           |            |
| 5.4.5    | Rated current                                                                               | A                    | ≥ 2000           |            |
| 5.4.6    | Rated short-circuit current (2 s)                                                           | kA rms               | 31.5             |            |
| 5.4.7    | Rated lightning impulse withstand voltage                                                   | kV peak              | 170              |            |
| 5.4.8    | Rated switching impulse withstand voltage                                                   | kV peak              | -                |            |
| 5.4.9    | Rated power frequency withstand voltage                                                     | kV rms               | 70               |            |
| 5.4.10   | Connectors                                                                                  |                      |                  |            |
| 5.4.10.1 | Shape                                                                                       | mm                   | Flat             |            |
| 5.4.10.2 | Length                                                                                      | mm                   | -                |            |
| 5.4.10.3 | Adjusted for Cu wire                                                                        |                      | Cu wire          |            |
| 5.4.11   | Minimum creepage distance (25 mm/kV)                                                        | mm/kV                | ≥ 25 mm/kV       |            |
| 5.4.12   | Full vacuum withstand of complete bushing                                                   |                      | YES              |            |
| <b>6</b> | <b>Design Data</b>                                                                          |                      |                  |            |
| 6.1      | Maximum flux density in the legs<br>• At rated voltage<br>• At 105 % of the rated voltage   | T<br>T               | Insert<br>Insert |            |
| 6.2      | Maximum flux density in the yokes:<br>• At rated voltage<br>• At 105 % of the rated voltage | T<br>T               | Insert<br>Insert |            |

| No.      | Description                                                                                                                                                                                      | Minimum Requirements                                        |                                                      | Guaranteed |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------|------------|
|          |                                                                                                                                                                                                  | Unit                                                        | Data                                                 |            |
| 6.3      | Maximum current density in windings at rated power and normal tap changer position:<br>• HV winding<br>• MV winding<br>• LV - stabilizing winding                                                | A/mm <sup>2</sup><br>A/mm <sup>2</sup><br>A/mm <sup>2</sup> | Insert<br>Insert<br>Insert                           |            |
| 6.4      | Winding resistance at 75°C and middle tap changer position:<br>• HV winding<br>• MV winding<br>• LV - stabilizing winding                                                                        | Ω<br>Ω<br>Ω                                                 | Insert<br>Insert<br>Insert                           |            |
| 6.5      | Core construction                                                                                                                                                                                |                                                             |                                                      |            |
| 6.5.1    | Method of joining of legs                                                                                                                                                                        |                                                             | Insert                                               |            |
| 6.5.2    | Method of joining of yokes                                                                                                                                                                       |                                                             | Insert                                               |            |
| 6.5.3    | Joining material                                                                                                                                                                                 |                                                             | Insert                                               |            |
| 6.5.4    | Number of legs                                                                                                                                                                                   |                                                             | Insert                                               |            |
| 6.5.5    | Type of core steel                                                                                                                                                                               |                                                             | Insert                                               |            |
| 6.5.6    | Specific loss of core steel at 1.7 T inductance                                                                                                                                                  | W/kg                                                        | < 1.11                                               |            |
| 6.6      | Winding conductor                                                                                                                                                                                |                                                             |                                                      |            |
| 6.6.1    | HV winding                                                                                                                                                                                       |                                                             | Cu - Interleaved & Continuous                        |            |
| 6.6.2    | MV winding                                                                                                                                                                                       |                                                             | Cu - Continuous                                      |            |
| 6.6.3    | LV - stabilizing winding                                                                                                                                                                         |                                                             | Cu - Helical                                         |            |
| 6.7      | Audible noise level (acc. to NEMA TR1), at 105 % of rated voltage, at maximum power and with complete cooling system in service                                                                  | dB                                                          | Insert                                               |            |
| 6.8      | Radio Interference Voltage at 0.5 MHz as specified in IEC 60694                                                                                                                                  | μV                                                          | 2500 max                                             |            |
| <b>7</b> | <b>Weights and dimensions</b>                                                                                                                                                                    |                                                             |                                                      |            |
| 7.1      | Total weight of autotransformer, equipped for service                                                                                                                                            | kg                                                          | less or equals to attached GA value*                 |            |
| 7.2      | Core and oil assembly                                                                                                                                                                            | kg                                                          | insert*                                              |            |
| 7.3      | Total mass excluding oil                                                                                                                                                                         | kg                                                          | insert*                                              |            |
| 7.4      | Tank and accessories                                                                                                                                                                             | kg                                                          | insert*                                              |            |
| 7.5      | Oil mass in tank                                                                                                                                                                                 | kg                                                          | insert*                                              |            |
| 7.6      | Oil mass in coolers                                                                                                                                                                              | kg                                                          | insert*                                              |            |
| 7.7      | Oil mass total                                                                                                                                                                                   | kg                                                          | insert*                                              |            |
| 7.8      | Total mass                                                                                                                                                                                       | kg                                                          | insert*                                              |            |
| 7.9      | Maximum shipping weight (the heaviest item)                                                                                                                                                      | kg                                                          | insert*                                              |            |
| 7.10     | Height from foundation to:<br>• Highest point of HV bushing<br>• Highest point of tank<br>• Highest point of conservator<br>• Highest point of lifting hook for removal of core and oil assembly | mm<br>mm<br>mm<br>mm                                        | As per GA*<br>As per GA*<br>As per GA*<br>As per GA* |            |

| No.       | Description                                                                                     | Minimum Requirements |                                                                         | Guaranteed |
|-----------|-------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------------------------------|------------|
|           |                                                                                                 | Unit                 | Data                                                                    |            |
| 7.11      | Outer dimensions:<br>• Length<br>• Width                                                        | mm<br>mm             | As per GA*<br>As per GA*                                                |            |
| 7.12      | Informative dimensional sketch                                                                  |                      | To be enclosed with bid                                                 |            |
| 7.13      | Maximum shipping dimensions of tank:<br>• Outside height<br>• Outside width<br>• Outside length | mm<br>mm<br>mm       | insert                                                                  |            |
| 7.14      | Transportation drawing                                                                          |                      | To be enclosed with bid                                                 |            |
| <b>8</b>  | <b>Tap changer</b>                                                                              |                      |                                                                         |            |
| 8.1       | Manufacturer                                                                                    |                      | Insert                                                                  |            |
| 8.2       | Type                                                                                            |                      | Insert                                                                  |            |
| 8.3       | Insulation level                                                                                | kV                   | Li 1050                                                                 |            |
| 8.4       | Rated current                                                                                   | A                    | ≥ 1000                                                                  |            |
| 8.5       | Number of steps                                                                                 |                      | 17                                                                      |            |
| 8.6       | Regulating coil                                                                                 |                      | At auto point                                                           |            |
| 8.7       | Short-circuit withstand                                                                         | kA rms               | Insert                                                                  |            |
| 8.8       | BIL to ground through the regulating coil                                                       | kV peak              | Insert                                                                  |            |
| 8.9       | Power frequency withstand voltage for 1 minute through the regulating coil                      | kV rms               | Insert                                                                  |            |
| 8.10      | Tap position indicator                                                                          |                      | Digital code matrix (BCD)                                               |            |
| 8.11      | Auxiliary supply                                                                                |                      | 3x400 V / 230 V, 50 Hz                                                  |            |
| 8.12      | Type of control                                                                                 |                      | On load local, remote and supervisory electrical and hand operation     |            |
| <b>9</b>  | <b>Auxiliary power supply</b>                                                                   |                      |                                                                         |            |
| 9.1       | Motors                                                                                          |                      | 3x400 V / 50 Hz                                                         |            |
| 9.2       | Heaters                                                                                         |                      | 230 V / 50 Hz                                                           |            |
| 9.3       | Control voltage                                                                                 |                      | 110 V DC                                                                |            |
| 9.4       | Oil pump                                                                                        |                      | 3x400 V / 50 Hz                                                         |            |
| <b>10</b> | <b>Current transformer incorporated into the power autotransformer</b>                          |                      |                                                                         |            |
| 10.1      | CT in HV bushings, for protection, WTI and/or Tap Changer                                       |                      | In all phases, 3 cores characteristics shall be defined in design stage |            |
| 10.2      | CT in MV bushings, for protection, WTI and/or Tap Changer                                       |                      | In all phases, 3 cores characteristics shall be defined in design stage |            |
| 10.3      | CT in neutral bushing , for protection                                                          |                      | In all phases, 3cores characteristics shall be defined in design stage  |            |
| 10.4      | CT in LV bushings, for protection                                                               |                      | In all phases, 3 cores characteristics shall be defined in design stage |            |
| <b>11</b> | <b>Layout</b>                                                                                   |                      |                                                                         |            |
| 11.1      | Primary winding bushings                                                                        |                      | Longitudinal axis                                                       |            |
| 11.2      | Secondary winding bushings                                                                      |                      | Longitudinal axis (opposite to HV)                                      |            |

| No.       | Description                                                           | Minimum Requirements |                                                                                 | Guaranteed |
|-----------|-----------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------------|------------|
|           |                                                                       | Unit                 | Data                                                                            |            |
| 11.3      | Conservator tank                                                      |                      | To be defined in design stage                                                   |            |
| 11.4      | Tap changer                                                           |                      | To be defined in design stage                                                   |            |
| 11.5      | Control cabinet                                                       |                      | To be defined in design stage                                                   |            |
| 11.6      | Coolers                                                               |                      | To be defined in design stage                                                   |            |
| 11.7      | Connection drawing, block diagram                                     |                      | To be enclosed with bid                                                         |            |
| <b>12</b> | <b>Cooling groups</b>                                                 |                      |                                                                                 |            |
| 12.1      | Number of cooling groups (total)                                      | Qty.                 | 4                                                                               |            |
| 12.2      | Number of cooling groups (for rated power)                            | Qty.                 | 3                                                                               |            |
| 12.3      | Number of stand-by cooling groups                                     | Qty.                 | 1                                                                               |            |
| 12.4      | Number of coolers in a cooling group                                  | Qty.                 | Insert                                                                          |            |
| 12.5      | Number of spare fans                                                  | Qty.                 | Insert (One fan in each group with failing of one fan shall not reduce the MCR) |            |
| 12.6      | Rating of each cooler                                                 | kW                   | Insert                                                                          |            |
| 12.7      | Power factor of the fan motor of each fan                             |                      |                                                                                 |            |
| 12.8      | Full vacuum with stand of complete cooler                             | mbar                 | Yes                                                                             |            |
| <b>13</b> | <b>Dehydrating breather</b>                                           |                      |                                                                                 |            |
| 13.1      | Type of dehydrating breather                                          |                      | Insert                                                                          |            |
| 13.2      | Dehumidifying agent                                                   | kg                   | Insert                                                                          |            |
| <b>14</b> | <b>Autotransformer tank</b>                                           |                      |                                                                                 |            |
| 14.1      | Type of design                                                        |                      |                                                                                 |            |
| 14.2      | Thickness of transformer tank:<br>• Sides<br>• Bottom<br>• Top        | mm<br>mm<br>mm       | Insert<br>Insert<br>Insert                                                      |            |
| 14.3      | Material of the autotransformer tank                                  |                      | Insert                                                                          |            |
| 14.4      | Wheels                                                                |                      |                                                                                 |            |
| 14.4.1    | Wheel number for each rail of two pair rails                          |                      | Two pairs                                                                       |            |
| 14.4.2    | Axial inter space in transversal direction between two pairs of rails | mm                   | insert                                                                          |            |
| 14.4.3    | Transversal distance between wheels in pair                           | mm                   | insert                                                                          |            |
| 14.4.4    | Distance between wheels in longitudinal direction                     | mm                   | insert                                                                          |            |
| 14.5      | Corrosion protection of the tank                                      |                      | YES                                                                             |            |
| 14.6      | Vacuum withstand of the complete tank with cooler                     | mbar                 | insert                                                                          |            |
| 14.7      | Over-pressure withstand of the complete auto-transformer              | bar                  | insert                                                                          |            |
| <b>15</b> | <b>Conservator</b>                                                    |                      |                                                                                 |            |
| 15.1      | Type                                                                  |                      | With diaphragm                                                                  |            |
| 15.2      | Number of compartments                                                | pcs.                 | 2                                                                               |            |

|      |                                                                                                                                         |                |        |  |
|------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------|--------|--|
| 15.3 | Total volume of conservator                                                                                                             | m <sup>3</sup> | Insert |  |
| 15.4 | Minimum volume of conservator between highest and lowest levels as percentage of total cold oil at 0°C of the volume of autotransformer | %              | Insert |  |

| No.       | Description                                                                                                                                                                                                 | Minimum Requirements |                            | Guaranteed |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------|------------|
|           |                                                                                                                                                                                                             | Unit                 | Data                       |            |
| 15.5      | Pressure rise inside the tank due to oil expansion                                                                                                                                                          |                      | Insert                     |            |
| 15.6      | Diagraph design parameters: <ul style="list-style-type: none"> <li>Maximum diagraph stress at highest working pressure</li> <li>Diagraph construction details</li> <li>Type of diagraph material</li> </ul> |                      | Insert<br>Insert<br>Insert |            |
| 15.7      | Corrosion protection of conservator                                                                                                                                                                         |                      | Insert                     |            |
| 15.8      | Oil level indicators with alarm for minimum oil level                                                                                                                                                       | pcs.                 | 2                          |            |
| <b>16</b> | <b>Operating conditions</b>                                                                                                                                                                                 |                      |                            |            |
| 16.1      | At the altitude (above sea level)                                                                                                                                                                           | m                    | ≤ 1000                     |            |
| 16.2      | Maximum ambient temperature                                                                                                                                                                                 | °C                   | + 45                       |            |
| 16.3      | Average daily temperature                                                                                                                                                                                   | °C                   | + 35                       |            |
| 16.4      | Average annual temperature                                                                                                                                                                                  | °C                   | + 30                       |            |
| 16.5      | Minimum ambient temperature                                                                                                                                                                                 | °C                   | - 5                        |            |
| 16.6      | Tertiary winding                                                                                                                                                                                            |                      | Will be used               |            |
| 16.7      | Parallel operation                                                                                                                                                                                          |                      | Yes                        |            |
|           | <b>Overall compliance with the requirements (yes/no)</b>                                                                                                                                                    |                      |                            |            |

\* Guaranteed values subject to deduction from Contract Price

\*\*These values are required for Foundation design & shipping purpose only. During detail design, these values may vary from Bid value due to attaining desired electrical output.

\* Estimated values. Actual values shall be measured during execution of the contract and shall be included on the name plate.

## 2.3 33/0.415 kV EARTHING/AUXILIARY TRANSFORMERS

| No.      | Description                                                                             | Minimum Requirements |                                                                                                                        | Guaranteed |
|----------|-----------------------------------------------------------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------|------------|
|          |                                                                                         | Unit                 | Data                                                                                                                   |            |
| <b>1</b> | <b>General</b>                                                                          |                      |                                                                                                                        |            |
| 1.1      | Manufacturer                                                                            |                      | Insert                                                                                                                 |            |
| 1.2      | Type                                                                                    |                      | Power transformer three-phase, oil immersed, two windings, without tertiary winding, with off-load tapchanger, outdoor |            |
| 1.3      | Model designation                                                                       |                      | Insert                                                                                                                 |            |
| 1.4      | Country of origin                                                                       |                      | Insert                                                                                                                 |            |
| 1.5      | Standards                                                                               |                      | IEC 60076                                                                                                              |            |
| 1.6      | Quality control                                                                         |                      | ISO 9001                                                                                                               |            |
| <b>2</b> | <b>Ratings and properties</b>                                                           |                      |                                                                                                                        |            |
| 2.1      | Rated power:                                                                            | kVA                  | 500<br>(As per BoQ)                                                                                                    |            |
| 2.2      | Type of cooling ONAN / ONAF                                                             | -                    | ONAN                                                                                                                   |            |
| 2.3      | Rated voltage of windings:<br>• HV winding<br>• LV winding                              | k<br>V<br>V          | 33<br>415                                                                                                              |            |
| 2.4      | Tap changer:<br>• Type of tap changing<br>• Tapping range<br>• Tapping step<br>• Rating | %<br>%               | Off-load<br>±5<br>2.5<br>Rated power 500 kVA, alltaps (As per BoQ)<br>(Calculation is required)                        |            |
| 2.5      | Frequency                                                                               | Hz                   | 50                                                                                                                     |            |
| 2.6      | Connection of three-phase windings (group of vector IEC 60076)                          |                      | ZNyn11                                                                                                                 |            |
| <b>3</b> | <b>Special technical requirements</b>                                                   |                      |                                                                                                                        |            |
| 3.1      | Power transformer capacity to withstand external short circuits                         |                      |                                                                                                                        |            |
| 3.1.1    | Short-circuit duration                                                                  | s                    | 3                                                                                                                      |            |

| No.   | Description                                                                                                              | Minimum Requirements |              | Guaranteed |
|-------|--------------------------------------------------------------------------------------------------------------------------|----------------------|--------------|------------|
|       |                                                                                                                          | Unit                 | Data         |            |
| 3.1.2 | Symmetrical short-circuit with-stand capacity and asymmetrical short-circuit withstand capacity during indicated period: |                      |              |            |
|       | • HV winding                                                                                                             | kA                   | 31.5         |            |
|       | • LV winding                                                                                                             | kA                   | 15           |            |
| 3.2   | Guaranteed losses                                                                                                        |                      |              |            |
| 3.2.1 | No-load losses with tap changer in normal position, at rated voltage and rated frequency                                 | kW                   | Insert       |            |
| 3.2.2 | Tolerance to be applied to no-load losses in % of the guaranteed value                                                   | %                    | 10           |            |
| 3.2.3 | On-load losses at 75°C, at rated voltage and rated frequency, with tap changer in normal position                        | kW                   | Insert       |            |
| 3.2.4 | Tolerance to be applied to on-load losses in % on the guaranteed value                                                   | %                    | 10           |            |
| 3.3   | Insulation level                                                                                                         |                      |              |            |
| 3.3.1 | Medium voltage (MV)                                                                                                      |                      | LI 170 AC 70 |            |
| 3.3.2 | Low voltage (LV)                                                                                                         |                      | LI - AC 3    |            |
| 3.4   | The highest voltage for equipment (effective value)                                                                      |                      |              |            |
| 3.4.1 | Medium voltage (MV)                                                                                                      | kV                   | 36           |            |
| 3.4.2 | Low voltage (LV)                                                                                                         | kV                   | 1.1          |            |
| 3.5   | Temperature rise limits, at rated power, with complete cooling system in service and at lowest voltage tap               |                      |              |            |
| 3.5.1 | Top oil                                                                                                                  | K                    | ≤ 60         |            |
| 3.5.2 | Winding                                                                                                                  | K                    | ≤ 65         |            |
| 3.5.3 | Hottest spot                                                                                                             | K                    | ≤ 65         |            |
| 4     | <b>Oil</b>                                                                                                               |                      |              |            |
| 4.1   | New                                                                                                                      |                      | Insert       |            |
| 4.2   | Manufacturer                                                                                                             |                      | Insert       |            |
| 4.3   | Type                                                                                                                     |                      | Insert       |            |
| 4.4   | Standard                                                                                                                 |                      | IEC 60296    |            |
| 4.5   | Minimum flash point                                                                                                      | °C                   | Insert       |            |
| 4.6   | Viscosity at 20°C                                                                                                        | mm <sup>2</sup> /s   | Insert       |            |
| 4.7   | Maximum dielectric strength                                                                                              | kV/cm                | Insert       |            |
| 4.8   | Data sheet attached                                                                                                      |                      | Insert       |            |

| No.      | Description                                                                                                                                                             | Minimum Requirements                   |                    | Guaranteed |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--------------------|------------|
|          |                                                                                                                                                                         | Unit                                   | Data               |            |
| 4.9      | Corrosive Sulphur                                                                                                                                                       |                                        | <b>NO</b>          |            |
| 4.10     | PCB content                                                                                                                                                             |                                        | <b>Without PCB</b> |            |
| <b>5</b> | <b>Bushing</b>                                                                                                                                                          |                                        |                    |            |
| 5.1      | MV bushing (36 kV)                                                                                                                                                      |                                        |                    |            |
| 5.1.1    | Quantity                                                                                                                                                                |                                        | 3 + 1              |            |
| 5.1.2    | Class                                                                                                                                                                   | kV                                     | 36                 |            |
| 5.1.3    | Manufacturer                                                                                                                                                            |                                        | Insert             |            |
| 5.1.4    | Type                                                                                                                                                                    |                                        | Insert             |            |
| 5.1.5    | Model                                                                                                                                                                   |                                        | Insert             |            |
| 5.1.6    | Rated current                                                                                                                                                           | A                                      | ≥ 100              |            |
| 5.1.7    | Rated short circuit current (3 s)                                                                                                                                       | kA rms                                 | 31.5               |            |
| 5.1.8    | Rated lightning impulse withstand voltage                                                                                                                               | kV peak                                | 170                |            |
| 5.1.9    | Rated switching impulse withstand voltage                                                                                                                               | kV peak                                | N.A.               |            |
| 5.1.10   | Rated power frequency withstand voltage                                                                                                                                 | kV rms                                 | 70                 |            |
| 5.1.11   | Minimum creepage distance (25 mm/kV)                                                                                                                                    | mm/kV                                  | ≥ 25 mm/kV         |            |
| 5.2      | LV bushings (3 kV)                                                                                                                                                      |                                        |                    |            |
| 5.2.1    | Quantity                                                                                                                                                                |                                        | 3 + 1              |            |
| 5.2.2    | Class                                                                                                                                                                   | kV                                     | 3                  |            |
| 5.2.3    | Manufacturer                                                                                                                                                            |                                        | Insert             |            |
| 5.2.4    | Type                                                                                                                                                                    |                                        | Insert             |            |
| 5.2.5    | Model                                                                                                                                                                   |                                        | Insert             |            |
| 5.2.6    | Rated current                                                                                                                                                           | A                                      | ≥ 1000A            |            |
| 5.2.7    | Rated short-circuit current (3 s)                                                                                                                                       | kA rms                                 | 15                 |            |
| 5.2.8    | Rated lightning impulse withstand voltage                                                                                                                               | kV peak                                | N.A.               |            |
| 5.2.9    | Rated switching impulse withstand voltage                                                                                                                               | kV peak                                | -                  |            |
| 5.2.10   | Rated power frequency withstand voltage                                                                                                                                 | kV rms                                 | 3                  |            |
| 5.2.11   | Minimum creepage distance (25 mm/kV)                                                                                                                                    | mm/kV                                  | ≥ 25 mm/kV         |            |
| <b>6</b> | <b>Design data</b>                                                                                                                                                      |                                        |                    |            |
| 6.1      | Maximum flux density, at rated voltage                                                                                                                                  | TT                                     | Insert             |            |
| 6.2      | Maximum current density in windings at rated power and normal tap changer position:<br><ul style="list-style-type: none"> <li>HV winding</li> <li>LV winding</li> </ul> | A/mm <sup>2</sup><br>A/mm <sup>2</sup> | Insert<br>Insert   |            |

| No.       | Description                                                                  | Minimum Requirements |                                                                           | Guaranteed |
|-----------|------------------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------|------------|
|           |                                                                              | Unit                 | Data                                                                      |            |
| 6.4       | Winding resistance at 75°C and middle tap changer position:                  |                      |                                                                           |            |
|           | • HV winding                                                                 | Ω                    | Insert                                                                    |            |
|           | • LV winding                                                                 | Ω                    | Insert                                                                    |            |
| <b>7</b>  | <b>Weights and dimensions</b>                                                |                      |                                                                           |            |
| 7.1       | Total weight of transformer, equipped for service                            | kg                   | *Insert                                                                   |            |
| 7.10      | Height from foundation to highest point of HV bushing                        | mm                   | *Insert                                                                   |            |
| 7.11      | Outer dimensions:                                                            |                      |                                                                           |            |
|           | • Length                                                                     | m                    | *Insert                                                                   |            |
|           | • Width                                                                      | m                    | *Insert                                                                   |            |
| 7.12      | Informative dimensional sketch                                               |                      | To be enclosed with bid                                                   |            |
| 7.13      | Maximum shipping dimensions of tank:                                         |                      |                                                                           |            |
|           | • Outside height                                                             | mm                   | *Insert                                                                   |            |
|           | • Outside width                                                              | mm                   | *Insert                                                                   |            |
|           | • Outside length                                                             | mm                   | *Insert                                                                   |            |
| 7.14      | Transportation drawing                                                       |                      | To be enclosed with bid                                                   |            |
| <b>8</b>  | <b>Dehydrating breather</b>                                                  |                      |                                                                           |            |
| 8.1       | Type of dehydrating breather                                                 |                      | Insert                                                                    |            |
| 8.2       | Dehumidifying agent                                                          | kg                   | Insert                                                                    |            |
| <b>9</b>  | <b>Conservator</b>                                                           |                      |                                                                           |            |
| 9.1       | Type                                                                         |                      | With dehydrating breather                                                 |            |
| 9.2       | Number of compartments                                                       | pcs.                 | 1                                                                         |            |
| 9.3       | Total volume of conservator                                                  | m <sup>3</sup>       | Insert                                                                    |            |
| 9.8       | Oil level indicators with alarm for minimum oil level                        | pcs.                 | 1                                                                         |            |
| <b>10</b> | <b>Current transformer incorporated into the auxiliary power transformer</b> |                      |                                                                           |            |
| 10.1      | CT in all HV bushings, for protection                                        |                      | In all bushings, 3 cores characteristics shall be defined in design stage |            |
| 10.2      | CT in all LV bushings, for protection                                        |                      | In all bushings, 3 cores characteristics shall be defined in design stage |            |
| <b>10</b> | <b>Operating conditions</b>                                                  |                      |                                                                           |            |
| 10.1      | At the altitude (above sea level)                                            | m                    | ≤ 1000                                                                    |            |
| 10.2      | Maximum ambient temperature                                                  | °C                   | + 40                                                                      |            |
| 10.3      | Average daily temperature                                                    | °C                   | + 35                                                                      |            |

| No.                                               | Description                 | Minimum Requirements |      | Guaranteed |
|---------------------------------------------------|-----------------------------|----------------------|------|------------|
|                                                   |                             | Unit                 | Data |            |
| 10.4                                              | Average annual temperature  | °C                   | + 30 |            |
| 10.5                                              | Minimum ambient temperature | °C                   | – 5  |            |
| Overall compliance with the requirements (yes/no) |                             |                      |      |            |

### PART-3 Cable

#### 3.1 33 KV XLPE POWER CABLES

| SI No. | Description                         | Unit            | Requirement                                                           | Bidder's Data |
|--------|-------------------------------------|-----------------|-----------------------------------------------------------------------|---------------|
|        | General                             |                 |                                                                       |               |
|        | Manufacturer                        |                 | Insert                                                                |               |
|        | Type                                |                 | Insert                                                                |               |
|        | Model Designation                   |                 | Insert                                                                |               |
|        | Country of Origin                   |                 | Insert                                                                |               |
|        | Standards                           |                 | EC 60502:2                                                            |               |
|        | Quality Control                     |                 | ISO 9001<br>ISO 14001<br>ISO 18001                                    |               |
|        | Type of conductor                   |                 | Copper                                                                |               |
|        | Type of Insulation                  |                 | XLPE                                                                  |               |
|        | Ambient temperature for calculation | °C              | 40                                                                    |               |
|        | Average daily temperature           | °C              | 50                                                                    |               |
|        | maximum daily temperature           |                 |                                                                       |               |
|        | Voltage                             |                 |                                                                       |               |
|        | Rated Voltage                       | kV              | 33kV                                                                  |               |
|        | Maximum System Voltage              | kV              | 36kV                                                                  |               |
|        | Impulse withstand voltage           | kV              | 170                                                                   |               |
|        | Power frequency withstand voltage   | kV              | 70                                                                    |               |
|        | Cores                               |                 |                                                                       |               |
|        | Number of cores                     |                 | 1 (one)                                                               |               |
|        | Conductor                           |                 |                                                                       |               |
|        | Standard                            |                 | IEC 60228                                                             |               |
|        | Nominal Current                     | A               | ≥ 2000                                                                |               |
|        | Cross sectional area                | mm <sup>2</sup> | Insert                                                                |               |
|        | Nominal Diameter                    | mm              | Insert                                                                |               |
|        | Material                            |                 | Annealed Copper                                                       |               |
|        | Design (standard of segmental)      |                 | Milliken (4/5 segment)                                                |               |
|        | Conductor Screen                    |                 |                                                                       |               |
|        | Material                            |                 | Semi conducting tape & Extruded semiconducting compound, cross linked |               |
|        | Thickness (approx.)                 | mm              | Insert                                                                |               |

| SI No. | Description                                                                                   | Unit | Requirement                                           | Bidder's Data |
|--------|-----------------------------------------------------------------------------------------------|------|-------------------------------------------------------|---------------|
|        | Nominal Diameter over semi-conducting layer                                                   | mm   | Insert                                                |               |
|        | Insulation                                                                                    |      |                                                       |               |
|        | Material                                                                                      |      | XLPE                                                  |               |
|        | Process                                                                                       |      | Triple simultaneous extrusion                         |               |
|        | Type of curing (dry)                                                                          |      | Dry Curing (VCV)                                      |               |
|        | Average Thickness                                                                             |      | IEC standard                                          |               |
|        | Minimum Thickness                                                                             |      | Insert                                                |               |
|        | Nominal Diameter over insulation                                                              |      | Insert                                                |               |
|        | Insulation screen                                                                             |      |                                                       |               |
|        | Material                                                                                      |      | Extruded semi conducting compound, cross linked       |               |
|        | Thickness approx.                                                                             |      | Insert                                                |               |
|        | Nominal Diameter over semi conducting layer                                                   |      | Insert                                                |               |
|        | Metallic Screen/Sheath                                                                        |      |                                                       |               |
|        | Type                                                                                          |      | Corrugated Seamless Aluminium Sheath                  |               |
|        | Thickness (nominal)                                                                           |      |                                                       |               |
|        | Nominal Diameter over semi Metallic sheath                                                    | mm   | Insert                                                |               |
|        | Longitudinal water tightness                                                                  |      |                                                       |               |
|        | Material                                                                                      |      | Semi-conducting swellable tape                        |               |
|        | Nominal thickness and width approx.                                                           |      | Insert                                                |               |
|        | Radial moisture barrier                                                                       |      |                                                       |               |
|        | Material                                                                                      |      | Laminated plastic coated aluminium tape / lead/copper |               |
|        | Nominal thickness and width approx.                                                           |      | Insert                                                |               |
|        |                                                                                               |      |                                                       |               |
|        | Outer Covering                                                                                |      |                                                       |               |
|        | Material                                                                                      |      | MDPE                                                  |               |
|        | Colour                                                                                        |      | Black                                                 |               |
|        | Minimum average thickness                                                                     |      | Insert                                                |               |
|        | Type of termite repellent                                                                     |      | Insert                                                |               |
|        | Completed Cable                                                                               |      | Insert                                                |               |
|        | Overall diameter (approx.)                                                                    | mm   | Insert                                                |               |
|        | Weight per meter (approx.)                                                                    | kg   | Insert                                                |               |
|        | Continuous Current carrying capacity based on the conditions special laid in the cable trench |      | SPB * & Trefoil                                       |               |

| SI No. | Description                                                                                             | Unit     | Requirement                                                                                | Bidder's Data |
|--------|---------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------------|---------------|
|        | One circuit                                                                                             |          | Insert                                                                                     |               |
|        | Two circuit                                                                                             |          | Insert                                                                                     |               |
|        | Three circuit                                                                                           |          | Insert                                                                                     |               |
|        | Drawn into ducts (One Cable in duct)                                                                    |          | Insert                                                                                     |               |
|        | One circuit                                                                                             |          |                                                                                            |               |
|        | Two circuit                                                                                             |          | Same as mentioned above provided the length of into the duct shall not exceed 5 % of route |               |
|        | Three Circuit                                                                                           |          | Insert                                                                                     |               |
|        | Continuous Current carrying capacity based on the conditions special laid in the cable trench           |          | FLAT                                                                                       |               |
|        | One circuit                                                                                             |          | Insert                                                                                     |               |
|        | Continuous Current carrying capacity based on the conditions special laid in the cable trench           |          | buried                                                                                     |               |
|        | One circuit                                                                                             |          | Insert                                                                                     |               |
|        | Max Conductor temperature                                                                               |          |                                                                                            |               |
|        | Laid direct ground                                                                                      | °C       | Insert                                                                                     |               |
|        | Draw into ducts                                                                                         | °C       | Insert                                                                                     |               |
|        | Elected in air                                                                                          | °C       | Insert                                                                                     |               |
|        | Permissible overload in service condition                                                               |          | 2 hrs in a day<br>100 hrs in a month<br>500 hrs in total life                              |               |
|        | Conductor short circuit current cable loaded as above prior to short circuit                            | KA/1sec  | Insert                                                                                     |               |
|        | Carrying capacity for three second cable loaded                                                         | KA/3sec  | Insert                                                                                     |               |
|        | Final conductor temperature                                                                             | °C       |                                                                                            |               |
|        | Sheath Earth Fault Current Carrying capacity for three second cable loaded as above prior to each fault | KA/1sec  | 50                                                                                         |               |
|        | Final Conductor temperature                                                                             | °C       | 250°                                                                                       |               |
|        | Max. Dielectric stress                                                                                  | kV/meter | Insert                                                                                     |               |
|        | on the conductor screen (assumed smooth)                                                                | kV/meter | Insert                                                                                     |               |
|        | on the insulation                                                                                       | kV/meter | Insert                                                                                     |               |
|        | Minimum radius of bend around which cable can be laid                                                   |          | 20 x overall diameter of cable in meters                                                   |               |
|        | Laid direct                                                                                             |          | Insert                                                                                     |               |
|        | In ducts                                                                                                |          | Insert                                                                                     |               |

| SI No. | Description                                                                                                                                       | Unit        | Requirement | Bidder's Data |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|---------------|
|        | In air                                                                                                                                            |             | Insert      |               |
|        | Nominal Internal diameter of pipes on ducts through which cable may be pulled (One cable in duct)                                                 |             | Insert      |               |
|        | Maximum DC resistance per km of cable at 20°C                                                                                                     | ohm/km      |             |               |
|        | Of conductor                                                                                                                                      | ohm/km      | Insert      |               |
|        | Of metallic layer                                                                                                                                 | ohm/km      | Insert      |               |
|        | Maximum ac resistance per km of cable at maximum conductor temperature                                                                            | ohm/km      | Insert      |               |
|        | Insulation Resistance per km of cable per core                                                                                                    |             |             |               |
|        | At 20°C                                                                                                                                           | mega ohm-km | Insert      |               |
|        | At maximum rated temperature                                                                                                                      | mega ohm-km | Insert      |               |
|        | Equivalent star Reactance per meter of 1 - phase circuit at nominal frequency                                                                     | ohm/km      | Insert      |               |
|        | Maximum electrostatic capacitance per meter of cable approx.                                                                                      | μF/km       | Insert      |               |
|        | Maximum charging current per core per meter pf cable at nominal voltage, U <sub>0</sub>                                                           | A/km        | Insert      |               |
|        | Maximum dielectric loss cable per uncl of 3 phase circuit when laid direct in the ground ay nominal                                               | W/m/phase   | Insert      |               |
|        | Maximum induced voltage on metal sheath under fault condition (single core only)                                                                  |             | Insert      |               |
|        | Maximum dielectric Dissipation factor of charging of cable when laid direct in the ground at nominal voltage U <sub>0</sub> , normal frequency at |             |             |               |
|        | Conductor temperature of 20°C                                                                                                                     |             | Insert      |               |
|        | Maximum conductor temperature of 90°C                                                                                                             |             | Insert      |               |
|        | Sheath loss of cable per meter of phase circuit at nominal voltage U <sub>0</sub> , normal frequency.                                             | W/m/phase   | Insert      |               |
|        | Cree page                                                                                                                                         | Mm          | Insert      |               |
|        | Total creepage distance of                                                                                                                        |             |             |               |

| SI No. | Description                                            | Unit            | Requirement | Bidder's Data |
|--------|--------------------------------------------------------|-----------------|-------------|---------------|
|        | outdoor sealing approx. mm and porcelain.              |                 |             |               |
|        | Earth continuity copper Conductor (IF REQD)            | mm <sup>2</sup> | Insert      |               |
|        | Condition on which current carrying capacity are based |                 |             |               |
|        | Soil thermal resistivity                               | °C-cm/W         | Insert      |               |
|        | Ground temperature                                     | °C              | Insert      |               |
|        | Air temperature                                        | °C              | Insert      |               |
|        | Burial depth                                           | M               | Insert      |               |
|        | Axial spacing between phase cables                     | Mm              | Insert      |               |
|        | Axial spacing between circuits                         | Mm              | Insert      |               |
|        | Type of earth bonding.                                 |                 | Insert      |               |

### 3.2 AUXILIARY POWER AND MULTICORE CONTROL CABLES

| Item                             |                 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |
|----------------------------------|-----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Number of core                   |                 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Core section                     | mm <sup>2</sup> |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Core diameter                    | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Conductor insulation             | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Type of filler                   |                 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Type of tape                     |                 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Sheath thickness                 | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Sheath outer diameter            | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Armour wires                     | no.             |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Armour wires diameter            | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Outer covering                   | type            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Outer covering thickness         |                 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Completed cable:                 |                 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| diameter                         | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| weight per metre                 | kg              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| maximum drum length              | m               |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Minimum installed bending radius | mm              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Maximum conductor temperature    | °C              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

## 2. PART 4 - DC EQUIPMENT

### 4.1 110 V BATTERIES

#### PART-A: (Employer Requirement:)

| No. | Description (Employer Requirement)                                                         | Unit   | Minimum Requirements Data           | Guaranteed |
|-----|--------------------------------------------------------------------------------------------|--------|-------------------------------------|------------|
|     | <b>110V Battery units (01 Set)</b>                                                         |        |                                     |            |
| 1.  | Standards                                                                                  |        | IEC 60623<br>IEC 60993              |            |
| 2.  | Quality control                                                                            |        | ISO 9001<br>ISO 14001<br>ISO 18001  |            |
| 3.  | Type of cell                                                                               |        | Nickel Cadmium (Ni-Cd)              |            |
| 4.  | Rated voltage                                                                              | V      | 110 V                               |            |
| 5.  | Number of cells per battery unit                                                           | pcs    | Not less than 92 nos.               |            |
| 6.  | Operating voltage per cell                                                                 | V      | 1.2                                 |            |
| 7.  | Floating voltage per cell                                                                  | V      | 1.40-1.42                           |            |
| 8.  | Equalizing/Boost Charging Voltage                                                          | V      | 1.5-1.75                            |            |
| 9.  | Rated capacity at 20°C                                                                     |        |                                     |            |
| a.  | • For 3h discharge time (C5)                                                               | Ah     | insert                              |            |
| b.  | • For 5h discharge time (C5)                                                               | Ah     | As per schedule A                   |            |
| c.  | • For 10h discharge time (C5)                                                              | Ah     | insert                              |            |
| 10. | ECV                                                                                        | V/Cell | 1.10                                |            |
| 11. | Spec. gravity of electrolyte                                                               | 1      | 1.19±0.01                           |            |
| 12. | Sp. gravity of electrolyte (Charged)                                                       | 1      | 1.19 ± 1%                           |            |
| 13. | Vent plug                                                                                  |        | Anti-corrosive & fire proof         |            |
| 14. | Positive plate                                                                             | -      | Tubular/pocket plate type/<br>other |            |
| 15. | Negative plate                                                                             | -      | Pasted/ pocket plate type/<br>other |            |
| 16. | Type of container                                                                          | -      | Translucent Polypropylene           |            |
| 17. | Cell condition                                                                             | -      | Pre-charged                         |            |
| 18. | The battery stands steel frame step type                                                   |        | Yes                                 |            |
| 19. | The battery stands earth-quake endurance type                                              |        | Yes                                 |            |
| 20. | Design Life                                                                                | years  | >20                                 |            |
| 21. | Vent plug                                                                                  |        | Anti-corrosive & fire<br>proof      |            |
| 22. | Overall compliance with above requirements & detail specification described in other PARTS | Yes/No | Yes                                 |            |

#### PART-B: (Manufacturer Information)

| No. | Description (To be inserted)       | Unit         | Manufacturer Information Data |
|-----|------------------------------------|--------------|-------------------------------|
|     | <b>110V Battery units (01 Set)</b> |              |                               |
| 1.  | Manufacturer                       |              | Insert                        |
| 2.  | Country of origin                  |              | Insert                        |
| 3.  | Type Designation                   |              | Insert                        |
| 4.  | Floating voltage per cell          | v(1.40-1.42) | Insert                        |
| 5.  | Equalizing/ Boost voltage per cell | V            | Insert                        |
| 6.  | Normal charging rate               | A            | Insert                        |

| No. | Description (To be inserted)                                                                                  | Manufacturer Information |                       |
|-----|---------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------|
|     |                                                                                                               | Unit                     | Data                  |
| 7.  | Maximum charging rate                                                                                         | A                        | Insert                |
| 8.  | Capacity at 5 hour rate                                                                                       | Ah                       | Insert                |
| 9.  | Ampere-hour efficiency at ten hour rate                                                                       | %                        | Insert                |
| 10. | Ampere-hour efficiency at one hour rate                                                                       | %                        | Insert                |
| 11. | Continuous Discharge Current                                                                                  | A                        | Insert                |
| 12. | Electrolyte                                                                                                   |                          | Insert                |
| 13. | Overall dimensions of one cell                                                                                | mm                       | Insert                |
| 14. | Dimensions of battery complete                                                                                | mm                       | Insert                |
| 15. | Quantity of electrolyte per one cell                                                                          | litre                    | Insert                |
| 16. | Length/width/height of assembled battery                                                                      | mm                       | Insert                |
| 17. | Weight of battery and stands in service                                                                       | kg                       | Insert (only battery) |
| 18. | Weight of cell complete with electrolyte                                                                      | kg                       | Insert                |
| 19. | Internal resistance per cell when fully charged                                                               | ohms                     | Insert                |
| 20. | Material of battery case                                                                                      |                          | Insert                |
|     | Overall compliance with detail specification described in other PARTS & existing Charger Module specification | Yes/No                   | Yes                   |

**PART-C: (Manufacturer Confirmation)**

| No.       | Description<br>(Guidelines to be followed)                                                                                                                                                                                                                                                                                              | Unit | PGCB's Requirement | Manufacturer Confirmation |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|---------------------------|
|           | <b>110V Battery units (01 Set)</b>                                                                                                                                                                                                                                                                                                      |      |                    |                           |
| 1.        | Dispatch condition of battery                                                                                                                                                                                                                                                                                                           |      | Pre-charged        |                           |
| <b>2.</b> | <b>Protection</b>                                                                                                                                                                                                                                                                                                                       |      |                    |                           |
| a.        | Safety pressure vent                                                                                                                                                                                                                                                                                                                    |      | Yes                |                           |
| b.        | Thermally welded cases for leak proof joints                                                                                                                                                                                                                                                                                            |      | Yes                |                           |
| <b>3.</b> | <b>Battery Marking</b>                                                                                                                                                                                                                                                                                                                  |      |                    |                           |
| a.        | Battery cells shall be clearly identified by permanent numbering                                                                                                                                                                                                                                                                        |      | Yes                |                           |
| b.        | Permanent identification with each Battery cell<br>(i) Manufacturer's name, reference No. & cell type<br>(ii) Year and month of manufacture<br>(iii) Voltage and nominal capacity at 10 hr. discharge rate<br>(iv) positive terminal: either a red washer or an indented or raised symbol<br>(v) maximum and minimum electrolyte levels |      | Yes                |                           |
| <b>4.</b> | <b>Accessories included</b>                                                                                                                                                                                                                                                                                                             |      |                    |                           |
| a.        | Nickle plated copper terminal post                                                                                                                                                                                                                                                                                                      |      | Yes                |                           |
| b.        | Nickle plated copper inter cell connectors, insulated copper cable connectors, connector cover, and end lug caps for each cell                                                                                                                                                                                                          |      | Yes                |                           |
| c.        | Electrolyte for each cell                                                                                                                                                                                                                                                                                                               |      | Yes                |                           |

| No. | Description<br>(Guidelines to be followed)                                                                                                                                                                                                                                                                                                 | Unit | PGCB's Requirement | Manufacturer Confirmation |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|---------------------------|
| d.  | A complete set of test and maintenance accessories including following items with each set of battery-<br>i) Two Syringe hydrometer<br>ii) Two cell-bridging connectors<br>iii) Two electrolyte-pouring funnels<br>iv) Two electrolyte thermometers<br>v) Battery instruction card for wall mounting<br>vi) Electrolyte airtight container |      | Yes                |                           |

## 4.2 48 V BATTERIES

### **PART-A: (Employer Requirement:)**

| No. | Description (Employer Requirement)                                                         | Minimum Requirements |                                     | Guaranteed |
|-----|--------------------------------------------------------------------------------------------|----------------------|-------------------------------------|------------|
|     |                                                                                            | Unit                 | Data                                |            |
|     | 48V Battery units (01 Set)                                                                 |                      |                                     |            |
| 23. | Standards                                                                                  |                      | IEC 60623<br>IEC 60993              |            |
| 24. | Quality control                                                                            |                      | ISO 9001<br>ISO 14001<br>ISO 18001  |            |
| 25. | Type of cell                                                                               |                      | Nickel Cadmium (Ni-Cd)              |            |
| 26. | Rated voltage                                                                              | V                    | 48 V                                |            |
| 27. | Number of cells per battery unit                                                           | pcs                  | Not less than 42 nos.               |            |
| 28. | Operating voltage per cell                                                                 | V                    | 1.2                                 |            |
| 29. | Floating voltage per cell                                                                  | V                    | 1.40-1.42                           |            |
| 30. | Equilizing/Boost Charging Voltage                                                          | V                    | 1.5-1.75                            |            |
| 31. | Rated capacity at 20°C                                                                     |                      |                                     |            |
| d.  | • For 3h discharge time (C5)                                                               | Ah                   | insert                              |            |
| e.  | • For 5h discharge time (C5)                                                               | Ah                   | As per schedule A                   |            |
| f.  | • For 10h discharge time (C5)                                                              | Ah                   | insert                              |            |
| 32. | ECV                                                                                        | V/Cell               | 1.10                                |            |
| 33. | Spec. gravity of electrolyte                                                               | l                    | 1.19±0.01                           |            |
| 34. | Sp. gravity of electrolyte (Charged)                                                       | l                    | 1.19 ± 1%                           |            |
| 35. | Vent plug                                                                                  |                      | Anti-corrosive & fire proof         |            |
| 36. | Positive plate                                                                             | -                    | Tubular/pocket plate type/<br>other |            |
| 37. | Negative plate                                                                             | -                    | Pasted/ pocket plate type/<br>other |            |
| 38. | Type of container                                                                          | -                    | Translucent Polypropylene           |            |
| 39. | Cell condition                                                                             | -                    | Pre-charged                         |            |
| 40. | The battery stands steel frame step type                                                   |                      | Yes                                 |            |
| 41. | The battery stands earth-quake endurance type                                              |                      | Yes                                 |            |
| 42. | Design Life                                                                                | years                | >20                                 |            |
| 43. | Vent plug                                                                                  |                      | Anti-corrosive & fire<br>proof      |            |
| 44. | Overall compliance with above requirements & detail specification described in other PARTS | Yes/No               | Yes                                 |            |

### **PART-B: (Manufacturer Information)**

| No. | Description (To be inserted) | Manufacturer Information |
|-----|------------------------------|--------------------------|
|-----|------------------------------|--------------------------|

|     |                                                                                                               | Unit         | Data                  |
|-----|---------------------------------------------------------------------------------------------------------------|--------------|-----------------------|
|     | <b>48V Battery units (01 Set)</b>                                                                             |              |                       |
| 21. | Manufacturer                                                                                                  |              | Insert                |
| 22. | Country of origin                                                                                             |              | Insert                |
| 23. | Type Designation                                                                                              |              | Insert                |
| 24. | Floating voltage per cell                                                                                     | V(1.40-1.42) | Insert                |
| 25. | Equalizing/ Boost voltage per cell                                                                            | V            | Insert                |
| 26. | Normal charging rate                                                                                          | A            | Insert                |
| 27. | Maximum charging rate                                                                                         | A            | Insert                |
| 28. | Capacity at 5 hour rate                                                                                       | Ah           | Insert                |
| 29. | Ampere-hour efficiency at ten hour rate                                                                       | %            | Insert                |
| 30. | Ampere-hour efficiency at one hour rate                                                                       | %            | Insert                |
| 31. | Continuous Discharge Current                                                                                  | A            | Insert                |
| 32. | Electrolyte                                                                                                   |              | Insert                |
| 33. | Overall dimensions of one cell                                                                                | mm           | Insert                |
| 34. | Dimensions of battery complete                                                                                | mm           | Insert                |
| 35. | Quantity of electrolyte per one cell                                                                          | litre        | Insert                |
| 36. | Length/width/height of assembled battery                                                                      | mm           | Insert                |
| 37. | Weight of battery and stands in service                                                                       | kg           | Insert (only battery) |
| 38. | Weight of cell complete with electrolyte                                                                      | kg           | Insert                |
| 39. | Internal resistance per cell when fully charged                                                               | ohms         | Insert                |
| 40. | Material of battery case                                                                                      |              | Insert                |
|     | Overall compliance with detail specification described in other PARTS & existing Charger Module specification | Yes/No       | Yes                   |

**PART-C: (Manufacturer Confirmation)**

| No.       | Description<br>(Guidelines to be followed)                                                                                                                                                                                                                                                                                              | Unit | PGCB's Requirement | Manufacturer Confirmation |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|---------------------------|
|           | <b>48V Battery units (01 Set)</b>                                                                                                                                                                                                                                                                                                       |      |                    |                           |
| 5.        | Dispatch condition of battery                                                                                                                                                                                                                                                                                                           |      | Pre-charged        |                           |
| <b>6.</b> | <b>Protection</b>                                                                                                                                                                                                                                                                                                                       |      |                    |                           |
| c.        | Safety pressure vent                                                                                                                                                                                                                                                                                                                    |      | Yes                |                           |
| d.        | Thermally welded cases for leak proof joints                                                                                                                                                                                                                                                                                            |      | Yes                |                           |
| <b>7.</b> | <b>Battery Marking</b>                                                                                                                                                                                                                                                                                                                  |      |                    |                           |
| c.        | Battery cells shall be clearly identified by permanent numbering                                                                                                                                                                                                                                                                        |      | Yes                |                           |
| d.        | Permanent identification with each Battery cell<br>(i) Manufacturer's name, reference No. & cell type<br>(ii) Year and month of manufacture<br>(iii) Voltage and nominal capacity at 10 hr. discharge rate<br>(iv) positive terminal: either a red washer or an indented or raised symbol<br>(v) maximum and minimum electrolyte levels |      | Yes                |                           |
| <b>8.</b> | <b>Accessories included</b>                                                                                                                                                                                                                                                                                                             |      |                    |                           |
| e.        | Nickle plated copper terminal post                                                                                                                                                                                                                                                                                                      |      | Yes                |                           |

| No. | Description<br>(Guidelines to be followed)                                                                                                                                                                                                                                                                                                 | Unit | PGCB's Requirement | Manufacturer Confirmation |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|---------------------------|
| f.  | Nickle plated copper inter cell connectors, insulated copper cable connectors, connector cover, and end lug caps for each cell                                                                                                                                                                                                             |      | Yes                |                           |
| g.  | Electrolyte for each cell                                                                                                                                                                                                                                                                                                                  |      | Yes                |                           |
| h.  | A complete set of test and maintenance accessories including following items with each set of battery-<br>i) Two Syringe hydrometer<br>ii) Two cell-bridging connectors<br>iii) Two electrolyte-pouring funnels<br>iv) Two electrolyte thermometers<br>v) Battery instruction card for wall mounting<br>vi) Electrolyte airtight container |      | Yes                |                           |

#### 4.3 110 V BATTERY CHARGER

| No.  | Description             | Minimum Requirements |                                                                    | Guaranteed |
|------|-------------------------|----------------------|--------------------------------------------------------------------|------------|
|      |                         | Unit                 | Data                                                               |            |
| 1.   | General                 |                      |                                                                    |            |
| 1.1  | Manufacturer            |                      | Insert                                                             |            |
| 1.2  | Type designation        |                      | Insert                                                             |            |
| 1.3  | Type                    |                      | Thyristor controlled                                               |            |
| 1.4  | Country of origin       |                      | Insert                                                             |            |
| 1.5  | Standards               |                      | IEC                                                                |            |
| 1.6  | Installation            |                      | Indoor                                                             |            |
| 1.7  | Rectifier type          |                      | Thyristor controlled.                                              |            |
| 1.8  | Rated D.C. voltage      | V                    | 110V $\pm 5\%$                                                     |            |
| 1.9  | Rated output current    | A                    | (refer to BOQ for detail)                                          |            |
| 1.10 | Charging mode           |                      | Both constant current & constant voltage                           |            |
| 1.11 | High Voltage Insulation | V                    | 1000 V AC for 1 minute between input to output and input to ground |            |
| 1.12 | Insulation resistance   | M $\Omega$           | 10 M $\Omega$ with 500V DC for 1minute                             |            |
| 1.13 | Cooling system          |                      | Self & natural air cooled.                                         |            |
| 1.14 | Relative humidity       | %                    | Up to 98%                                                          |            |
| 1.15 | Ambient temperature     | °C                   | 40 (max.)                                                          |            |
| 1.16 | Noise level             | db                   | 65 (max)                                                           |            |
| 1.21 | Altitude                |                      | 1000 m                                                             |            |
| 1.22 | Applicable Standard     | Hz                   | IEC or equivalent                                                  |            |
| 2.   | AC Input                |                      |                                                                    |            |

| No. | Description                                                          | Minimum Requirements |                                                          | Guaranteed |
|-----|----------------------------------------------------------------------|----------------------|----------------------------------------------------------|------------|
|     |                                                                      | Unit                 | Data                                                     |            |
| 2.1 | Voltage                                                              | V                    | 415                                                      |            |
| 2.2 | Phase                                                                |                      | 3                                                        |            |
| 2.3 | Frequency                                                            | Hz                   | 50±5%                                                    |            |
| 2.4 | Allowable Input AC voltage variation At Charger input terminal       | V                    | ±15%                                                     |            |
| 2.5 | Power factor                                                         |                      | 0.8                                                      |            |
| 2.6 | Efficiency (Full load)                                               | %                    | insert                                                   |            |
| 2.7 | Charge Characteristics                                               |                      | Constant current /Constant voltage (During float charge) |            |
| 2.8 | Current limitation                                                   | %                    | 110%                                                     |            |
| 3   | D.C. OUTPUT                                                          |                      |                                                          |            |
| 3.1 | Voltage                                                              | V                    | 110±5%                                                   |            |
| 3.2 | Ripple Voltage (Full load)                                           | %                    | ±2%                                                      |            |
| 3.3 | Charge modes (3 level)                                               |                      | Charge, Float charge & Boost charge                      |            |
| 3.4 | Float Voltage (adjustable)                                           | V                    | 1.42                                                     |            |
| 3.5 | Boost Voltage (adjustable)                                           | V                    | 1.53                                                     |            |
| 4   | Measurement                                                          |                      | As required                                              |            |
| 5   | Output current sharing facility (for parallel operation of chargers) |                      | Yes                                                      |            |
|     | Overall compliance with the requirements (yes/no)                    |                      |                                                          |            |

#### 4.4 48 V BATTERY CHARGER

| No.  | Description             | Minimum Requirements |                                                                    | Guaranteed |
|------|-------------------------|----------------------|--------------------------------------------------------------------|------------|
|      |                         | Unit                 | Data                                                               |            |
| 1.   | General                 |                      |                                                                    |            |
| 1.1  | Manufacturer            |                      | Insert                                                             |            |
| 1.2  | Type designation        |                      | Insert                                                             |            |
| 1.3  | Type                    |                      | Thyristor controlled                                               |            |
| 1.4  | Country of origin       |                      | Insert                                                             |            |
| 1.5  | Standards               |                      | IEC                                                                |            |
| 1.6  | Installation            |                      | Indoor                                                             |            |
| 1.7  | Rectifier type          |                      | Thyristor controlled.                                              |            |
| 1.8  | Rated D.C. voltage      | V                    | 48V ±5%                                                            |            |
| 1.9  | Rated output current    | A                    | (refer to BOQ for detail)                                          |            |
| 1.10 | Charging mode           |                      | Both constant current & constant voltage                           |            |
| 1.11 | High Voltage Insulation | V                    | 1000 V AC for 1 minute between input to output and input to ground |            |

| No.  | Description                                                          | Minimum Requirements |                                                          | Guaranteed |
|------|----------------------------------------------------------------------|----------------------|----------------------------------------------------------|------------|
|      |                                                                      | Unit                 | Data                                                     |            |
| 1.12 | Insulation resistance                                                | MΩ                   | 10 MΩ with 500V DC for 1minute                           |            |
| 1.13 | Cooling system                                                       |                      | Self & natural air cooled.                               |            |
| 1.14 | Relative humidity                                                    | %                    | Up to 98%                                                |            |
| 1.15 | Ambient temperature                                                  | °C                   | 40 (max.)                                                |            |
| 1.16 | Noise level                                                          | db                   | 65 (max)                                                 |            |
| 1.21 | Altitude                                                             |                      | 1000 m                                                   |            |
| 1.22 | Applicable Standard                                                  | Hz                   | IEC or equivalent                                        |            |
| 2.   | AC Input                                                             |                      |                                                          |            |
| 2.1  | Voltage                                                              | V                    | 415                                                      |            |
| 2.2  | Phase                                                                |                      | 3                                                        |            |
| 2.3  | Frequency                                                            | Hz                   | 50±5%                                                    |            |
| 2.4  | Allowable Input AC voltage variation At Charger input terminal       | V                    | ±15%                                                     |            |
| 2.5  | Power factor                                                         |                      | 0.8                                                      |            |
| 2.6  | Efficiency (Full load)                                               | %                    | insert                                                   |            |
| 2.7  | Charge Characteristics                                               |                      | Constant current /Constant voltage (During float charge) |            |
| 2.8  | Current limitation                                                   | %                    | 110%                                                     |            |
| 3    | D.C. OUTPUT                                                          |                      |                                                          |            |
| 3.1  | Voltage                                                              | V                    | 48±5%                                                    |            |
| 3.2  | Ripple Voltage (Full load)                                           | %                    | ±2%                                                      |            |
| 3.3  | Charge modes (3 level)                                               |                      | Charge, Float charge & Boost charge                      |            |
| 3.4  | Float Voltage (adjustable)                                           | V                    | 1.42                                                     |            |
| 3.5  | Boost Voltage (adjustable)                                           | V                    | 1.53                                                     |            |
| 4    | Measurement                                                          |                      | As required                                              |            |
| 5    | Output current sharing facility (for parallel operation of chargers) |                      | Yes                                                      |            |
|      | Overall compliance with the requirements (yes/no)                    |                      |                                                          |            |

**4.5 LV DC EQUIPMENT**

|    |                                            |    |  |
|----|--------------------------------------------|----|--|
|    | <b>DC Switchboard</b>                      |    |  |
| 30 | Manufacturer                               |    |  |
| 31 | Type                                       |    |  |
| 32 | Busbars:                                   |    |  |
|    | - maximum current rating                   | A  |  |
|    | - dimensions                               | mm |  |
| 33 | Boost charge contactors:                   |    |  |
|    | - manufacturer                             |    |  |
|    | - maximum current rating                   |    |  |
|    | - coil rating                              |    |  |
|    | - method of interlocking                   |    |  |
| 34 | Alarm relays:                              |    |  |
|    | - manufacturer                             |    |  |
|    | - type and reference                       |    |  |
|    | - power consumption:                       |    |  |
|    | a) quiescent                               | A  |  |
|    | b) operated                                | mA |  |
| 35 | Number and rating of distribution circuits |    |  |
| 36 | Overall dimensions                         | mm |  |
| 37 | Total weight                               | kg |  |

**PART 5 - LV AC EQUIPMENT**

| No.      | Description                       | Minimum Requirements |        | Guaranteed |
|----------|-----------------------------------|----------------------|--------|------------|
|          |                                   | Unit                 | Data   |            |
| <b>1</b> | <b>AC Distribution Panel</b>      |                      |        |            |
| 1.1      | Manufacturer                      |                      | Insert |            |
| 1.2      | Manufacturer's type designation   |                      | Insert |            |
|          | Country of origin                 |                      |        |            |
| 1.3      | Rating of Busbar                  | Amps                 | Insert |            |
| 1.4      | Fault Rating for 1 sec            | kA                   | Insert |            |
| 1.5      | Incomer Breaker Rating            | Amps                 | Insert |            |
| 1.6      | Voltage                           | Volts                | Insert |            |
| 1.7      | Thickness of sheet steel          | mm                   | Insert |            |
| <b>2</b> | <b>Miniature Circuit Breakers</b> |                      |        |            |
| 2.1      | Manufacturer                      |                      | Insert |            |
| 2.2      | Type                              |                      | Insert |            |
| 2.3      | Rating                            | Amps                 | Insert |            |
| 2.4      | Fault Rating for 1 sec            | kA                   | Insert |            |

|     |                                                                                     |     |     |  |
|-----|-------------------------------------------------------------------------------------|-----|-----|--|
| 2.5 | Overall compliance with the requirements & details specification described in Vol-2 | Yes | Yes |  |
|-----|-------------------------------------------------------------------------------------|-----|-----|--|

## PART 6

### Digital Fault and Disturbance Recorder [DFDR]

| SL  | ITEM                                                                 | UNITS                                        | PGCB'S REQUIREMENT                                                                                | Guaranteed |
|-----|----------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------------------|------------|
| (A) | GENERAL                                                              |                                              |                                                                                                   |            |
| 1.  | Manufacture's name and address                                       |                                              | To be mentioned                                                                                   |            |
| 2.  | Type                                                                 |                                              | To be mentioned                                                                                   |            |
| 3.  | Power supply                                                         | VDC                                          | 110                                                                                               |            |
| 4.  | -Power supply for printer                                            | VAC                                          | 240                                                                                               |            |
| (B) | ANALOGUE INPUTS                                                      |                                              |                                                                                                   |            |
| 1.  | Number of channel                                                    |                                              | As per required number of signals for particular feeders                                          |            |
|     | Expandability                                                        |                                              | As required for future feeders                                                                    |            |
| 2.  | Nominal current                                                      | Amp                                          | 1A/5A                                                                                             |            |
| 3.  | Nominal voltage                                                      | Vac/Vdc                                      |                                                                                                   |            |
|     | -Current                                                             | mA/Amp                                       |                                                                                                   |            |
| 4.  | Frequency response                                                   |                                              |                                                                                                   |            |
| 5.  | Cut –off frequency                                                   |                                              |                                                                                                   |            |
|     | Bandwidth                                                            | dB                                           | Insert                                                                                            |            |
|     | Attenuation at                                                       | dB                                           | Insert                                                                                            |            |
|     | (C) Auto adjusted anti-aliasing filters for chosen sampling rate     | Yes/No                                       | Yes                                                                                               |            |
|     | (d) Simultaneously programmable sampling rate for all feeders/inputs |                                              | 3 distinct programmable Sampling rates and generate 3 simultaneously distinct records             |            |
|     | -Locally Changeable<br>- Remotely Changeable                         | Yes/No<br>Yes/No                             | Yes<br>Yes                                                                                        |            |
|     | (e) Possible sampling rates                                          | Sample s/sec<br>Sample s/sec<br>Sample s/sec | 3 different sampling rates:<br>Slow. 1Hz-500Hz<br>Fast: 0.5kHz-6kHz<br>Continuous (variable rate) |            |
| 6.  | DC coupled inputs                                                    | Yes/No                                       | Yes, all Analog inputs should be capable of connecting AC or DC inputs as per site                |            |

| SL  | ITEM                                                                      | UNITS  | PGCB'S REQUIREMENT                                       | Guaranteed |
|-----|---------------------------------------------------------------------------|--------|----------------------------------------------------------|------------|
|     |                                                                           |        | requirement without changing any hardware .              |            |
| 7.  | Resolution                                                                | bits   | 16 bits                                                  |            |
| 8.  | Accuracy                                                                  | %      | Min 0.5                                                  |            |
| 9.  | Burden                                                                    |        |                                                          |            |
|     | 1.Current Circuit at IN                                                   | VA     | Insert                                                   |            |
|     | 2.Voltage Circuit                                                         | VA     | Insert                                                   |            |
| 10. | Over load                                                                 |        |                                                          |            |
|     | 1.Current                                                                 | % In   | 100% In continuously, Min 600% in for 1sec               |            |
|     | 2.Voltage Circuit                                                         | % Vn   | 2Vn and max. 350Vn                                       |            |
| (C) | DIGITAL INPUTS                                                            |        |                                                          |            |
| 1.  | Number of channel                                                         |        | As per required number of signals for particular feeders |            |
|     | -Expandability(without and time skew)                                     |        | As required for future feeders                           |            |
| 2.  | Selectable input level                                                    | Vdc    | N/O or N/C. 24,48,110 and 220 VDC                        |            |
| 3.  | Type                                                                      |        | Potential or potential free contract                     |            |
| 4.  | Resolution                                                                | ms     |                                                          |            |
| (D) | MEMORY                                                                    |        |                                                          |            |
| 1.  | Size                                                                      | MB     | 64 MB or Higher                                          |            |
| 2.  | Type                                                                      |        | SolidState                                               |            |
| 3.  | Pre-fault time (fast scanning rate)                                       | sec    | 0.1-2 user programmable                                  |            |
| 4.  | Post-fault (fast scanning rate)                                           | sec    | 0.1-2 user programmable                                  |            |
| 5.  | Pre and Post fault time (slow scanning rate)                              | sec    | min. 180 user programmable                               |            |
| 6.  | In-Build Flash disk (auto-maintained)                                     | GB     | min. 4 GB                                                |            |
| (E) | SENSORS/ TRIGGERING CRITERIA                                              |        |                                                          |            |
|     | All sensors/triggers are preferable Programmable and Virtually recordable | Yes/No | Yes                                                      |            |
| 1.  | Logical combination sensor                                                | Yes/No | Yes                                                      |            |
| 2.  | Three phase over or under Voltage/ Current                                | Yes/No | Yes                                                      |            |
| 3.  | Mono phase over or under Voltage/ Current                                 | Yes/No | Yes                                                      |            |
| 4.  | *du/dt, dp/dt, dq/dt, [Single/3 Phases], df/dt, etc.                      | Yes/No | Yes                                                      |            |
| 5.  | RMS [ Voltage/Current]                                                    | Yes/No | Yes                                                      |            |
| 6.  | Zero Sequence                                                             | Yes/No | Yes                                                      |            |
| 7.  | Negative, Positive Sequence                                               | Yes/No | Yes                                                      |            |
| 8.  | Frequency                                                                 | Yes/No | Yes                                                      |            |

| SL  | ITEM                                                          | UNITS         | PGCB'S REQUIREMENT                | Guaranteed |
|-----|---------------------------------------------------------------|---------------|-----------------------------------|------------|
| 9.  | DC Step                                                       | Yes/No        | Yes                               |            |
| 10. | Pending/Swing                                                 | Yes/No        | Yes                               |            |
| 11. | Digital level and edge                                        | Yes/No        | Yes                               |            |
| 12. | Sensor Trigger                                                | Yes/No        | Yes                               |            |
| 13. | Event Trigger                                                 | Yes/No        | Yes                               |            |
| 14. | Manual Trigger                                                | Yes/No        | Yes                               |            |
| 15. | Remote Trigger                                                | Yes/No        | Yes                               |            |
| (F) | CLOCK SYSTEM                                                  |               |                                   |            |
| 1.  | Internal Clock                                                | Yes/No        | Yes                               |            |
| 2.  | Accuracy                                                      |               |                                   |            |
| 3.  | External Synchronization                                      | Yes/No        | Yes                               |            |
| 4.  | Time resolution between 2 synchronized pulse                  |               |                                   |            |
| (G) | OUTPUT ALARM RELAY CONTACT                                    |               |                                   |            |
| 1.  | Max. operation Voltage DC/AC                                  | Vac/Vdc       | 250 Vac or above, 60 Vdc or above |            |
| 2.  | Make and carry for 0.5 sec                                    | A             | Min. 8A                           |            |
| 3.  | Carry continuously                                            | A             | Min. 5A                           |            |
| 4.  | Break (DC)-resistive                                          | W             |                                   |            |
| (H) | INTERFACE FOR DATA COMMUNICATION                              |               |                                   |            |
| 1.  | Full definition compression                                   | Yes/No        | Yes                               |            |
| 2.  | Maximum transmission rate                                     | Bits/Sec      |                                   |            |
| 3.  | Standard serial port (EIA-232-D)                              | Yes/No        | Yes                               |            |
| 4.  | Printer Port                                                  | Yes/No        | Yes                               |            |
| 5.  | Dedicated serial port for modem                               | Yes/No        | Yes                               |            |
| (I) | PRINTER DATA                                                  |               |                                   |            |
| 1.  | Printer amplitude (scaling peak to peak)                      |               |                                   |            |
| 2.  | Time Scale (mm/s)                                             |               |                                   |            |
| 3.  | Printer resolution                                            | mm            |                                   |            |
| 4.  | Auto printing                                                 | Yes/No        | Yes                               |            |
| (J) | Fault Priority transmission                                   | Yes/No        | Yes                               |            |
| (K) | Fault location (distance calculation)                         | Yes/No        | Yes                               |            |
| (L) | Test certificate from internationally recognized Laboratories | Yes/No        | Yes                               |            |
| (M) | COMMUNICATION AND REMOTE ANALYZING UNIT                       |               |                                   |            |
| 1.  | Processor Pentium                                             | (MHz), Yes/No | Yes, at least 450MHz Pentium      |            |
| 2.  | Co-Processor Pentium                                          | Yes/No        | Yes                               |            |
| 3.  | Main memory capacity                                          | (Mb), Yes/No  | Yes, at least 64Mb                |            |
| 4.  | Color graphics board S-VGA                                    | Yes/No        | Yes                               |            |
| 5.  | Screen S-VGA                                                  | Yes/No        | Yes                               |            |

| SL | ITEM           | UNITS  | PGCB'S REQUIREMENT | Guaranteed |
|----|----------------|--------|--------------------|------------|
| 6. | Hard disk unit | Yes/No | Yes, at least 40GB |            |
| 7. | Printer        | Yes/No | Yes                |            |
| 8. | Modem          | Yes/No | Yes                |            |

## 2.1.1 PART 7 – Control, Protection, Substation Automation & Metering

### 7.1 Line Distance Protection

| No. | Description                                   | Unit | Minimum Requirements                                                                                                                       | Guaranteed |
|-----|-----------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1   | Manufacturer                                  |      | ABB/SIEMENS/GE/SEL or equivalent.<br>(Switzerland/Sweden/Germany/UK/USA/ France or from other eligible countries with equivalent quality). |            |
| 2   | Country of Origin<br>(Place of Manufacturing) |      |                                                                                                                                            |            |
| 3   | Relay Identification                          |      |                                                                                                                                            |            |
| 3.1 | Relay Type & model                            |      | Insert (Main-01 & Main-02 shall be from different manufacturer)                                                                            |            |
| 3.2 | Relay Software version                        |      | Insert                                                                                                                                     |            |
| 3.3 | Relay Hardware version                        |      | Insert                                                                                                                                     |            |
| 4   | Language                                      |      | English                                                                                                                                    |            |
| 5   | Housing & mounting                            |      | Flush mounting housing and capable of sustaining in harsh environmental condition                                                          |            |
| 6   | Relay auxiliary voltage                       | V    | Minimum range of 88V to 250V DC and minimum range of 115V to 230V AC                                                                       |            |
| 7   | Operating frequency                           | Hz   | 50Hz, $\pm 5\%$                                                                                                                            |            |
| 8   | Current transformer requirement               |      |                                                                                                                                            |            |
| 8.1 | No of Inputs                                  | Nos  | 6                                                                                                                                          |            |
| 8.2 | Nominal current                               | A    | Operable in 1A and 5A (User settable)                                                                                                      |            |
| 8.3 | Minimum continuous                            | A    | 3 *Nominal current                                                                                                                         |            |

| No.  | Description                          | Unit   | Minimum Requirements                                                                                                                                                                                                                                                   | Guaranteed |
|------|--------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|      | current capacity                     |        |                                                                                                                                                                                                                                                                        |            |
| 8.4  | Thermal withstand capacity           | A      | 100*Nominal current for at least 1s                                                                                                                                                                                                                                    |            |
| 9    | Voltage transformer requirement      |        |                                                                                                                                                                                                                                                                        |            |
| 9.1  | No of Inputs                         | Nos.   | 6 (For Line VT & Bus VT)                                                                                                                                                                                                                                               |            |
| 9.2  | Nominal voltage                      | V      | 110                                                                                                                                                                                                                                                                    |            |
| 9.3  | Minimum continuous withstand voltage | V      | 150                                                                                                                                                                                                                                                                    |            |
| 10   | Binary input module                  |        |                                                                                                                                                                                                                                                                        |            |
| 10.1 | Minimum number of inputs             | Nos.   | 10 (programmable)<br>(Should be increased as per the scheme design)                                                                                                                                                                                                    |            |
| 10.2 | Minimum operating range              | V      | 110V DC ( $\pm 20\%$ tolerance)                                                                                                                                                                                                                                        |            |
| 11   | Binary output module                 |        |                                                                                                                                                                                                                                                                        |            |
| 11.1 | Minimum number of outputs            | Nos.   | 20 (minimum 8 Nos. high speed trip output and 2 Nos. watchdog outputs)<br>(Should be increased as per the scheme design)                                                                                                                                               |            |
| 11.2 | Minimum operating range              | V      | 110V and 220V DC ( $\pm 20\%$ tolerance)                                                                                                                                                                                                                               |            |
| 11.3 | Minimum continuous current capacity  | A      | 5                                                                                                                                                                                                                                                                      |            |
| 11.4 | Short time withstand capacity        | A      | 10A for at least 1s                                                                                                                                                                                                                                                    |            |
| 11.5 | Maximum operating time               | ms     | 5 (2ms for high speed contact)                                                                                                                                                                                                                                         |            |
| 12   | Number of LEDs                       | Nos.   | 15 (programmable)<br>(Should be increased as per the scheme design)                                                                                                                                                                                                    |            |
| 13   | HMI                                  |        | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                       |            |
| 14   | Software requirement                 |        | Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license |            |
| 14   | GPS Time synchronization             | Yes/No | Yes                                                                                                                                                                                                                                                                    |            |
| 16   | Communication interface              |        |                                                                                                                                                                                                                                                                        |            |
| 16.1 | Standard protocol                    |        | IEC 61850 (have to be able to                                                                                                                                                                                                                                          |            |

| No.   | Description                                                              | Unit    | Minimum Requirements                                                          | Guaranteed |
|-------|--------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------|------------|
|       |                                                                          |         | communicate to IEC 61850 based Substation Automation System)                  |            |
| 16.2  | Ethernet speed and connector                                             |         | 100Mbps, RJ45 plug connector/RS232 serial connector as front port             |            |
| 17    | Main protection function                                                 |         | Impedance protection                                                          |            |
| 17.1  | Tripping options                                                         |         | Single and/or three phases                                                    |            |
| 17.2  | Number of parameter setting groups                                       | Nos .   | Minimum 4 (Independently settable)                                            |            |
| 17.3  | Pre-configuration                                                        |         | For all basic functions                                                       |            |
| 17.4  | Number of impedance protection zones                                     | Nos .   | 5                                                                             |            |
| 17.5  | Shape of impedance zone                                                  |         | Mho/Quadrilateral                                                             |            |
| 17.6  | Reverse looking element                                                  |         | Settable in all 5 zones                                                       |            |
| 17.7  | Can resistance and reactance reaches be set independent of each other    | Yes /No | Yes                                                                           |            |
| 17.8  | Arc forward and reverse reach setting independent of each other?         | Yes /No | Yes                                                                           |            |
| 17.9  | Switch on to fault                                                       | Yes /No | Yes                                                                           |            |
| 17.10 | Out of Step                                                              | Yes /No | Yes                                                                           |            |
| 17.11 | Stub Protection                                                          | Yes /No | Yes                                                                           |            |
| 17.12 | Blind Fault Protection                                                   | Yes /No | Yes                                                                           |            |
| 17.13 | Power swing block                                                        | Yes /No | Yes                                                                           |            |
| 17.14 | Communication aided impedance protection                                 |         | PUTT, POTT, CB Echo logic, Weak infeed echo logic, DTT, Zone-1 extension etc. |            |
| 17.15 | Communication aided Directional Earth Fault                              | Yes /No | Yes                                                                           |            |
| 17.16 | Impedance zone operating time                                            | Sec     | Settable between 0s and 30s (or higher range) with step size of 0.01s         |            |
| 17.17 | Impedance setting range                                                  | Ohm     | 0.1 to 1000 or higher with the step size of 0.001/In                          |            |
| 17.18 | Relay Operating Time'<br>i) Output contact making time<br>ii) Relay Time | ms      | Insert                                                                        |            |

| No.  | Description                                           | Unit    | Minimum Requirements                                                                                                                                                 | Guaranteed |
|------|-------------------------------------------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 18   | Back up protection function                           |         | Instantaneous/delayed, directional/non-directional, over current and earth fault                                                                                     |            |
| 19   | Control functions                                     |         | Synchro check and 1P/3P auto-reclose for single and multi CB arrangements (1 set for Double busbar arrangement)                                                      |            |
| 20   | Monitoring functions                                  |         |                                                                                                                                                                      |            |
| 20.1 | Fuse failure supervision, current circuit supervision | Yes /No | Yes                                                                                                                                                                  |            |
| 20.2 | U, I, P, Q, S, f, PF monitoring                       | Yes /No | Yes                                                                                                                                                                  |            |
| 20.3 | Fault locator                                         | Yes /No | Yes                                                                                                                                                                  |            |
| 20.4 | Event records and oscillographic disturbance records  |         | Event recorder should keep at least 20Nos previous records and disturbance recorder should handle at least 8Nos analogue channels and at least 24Nos binary channels |            |
| 21   | Tripping and indication logics                        |         | Should be programmable                                                                                                                                               |            |
| 22   | Standards                                             |         | Should conform IEC-60255 in all aspects                                                                                                                              |            |
| 23   | Type test certificate                                 |         | Should be provided                                                                                                                                                   |            |

## 7.2 Line Differential Protection

| No. | Description                                | Unit | Minimum Requirements                                                                                                                   | Guaranteed |
|-----|--------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------|------------|
|     |                                            |      | Data                                                                                                                                   |            |
| 1   | Manufacturer                               |      | ABB/SIEMENS/GE/SEL or equivalent. (Switzerland/Sweden/Germany/UK/USA/France or from other eligible countries with equivalent quality). |            |
| 2   | Country of Origin (Place of Manufacturing) |      |                                                                                                                                        |            |
| 3   | Relay Identification                       |      |                                                                                                                                        |            |
| 3.1 | Relay Type & model                         |      | Insert (Main-01 & Main-02 shall be from different manufacturer)                                                                        |            |
| 3.2 | Relay Software version                     |      | Insert                                                                                                                                 |            |
| 3.3 | Relay Hardware                             |      | Insert                                                                                                                                 |            |

|      |                                      |      |                                                                                                                        |  |
|------|--------------------------------------|------|------------------------------------------------------------------------------------------------------------------------|--|
|      | version                              |      |                                                                                                                        |  |
| 4    | Language                             |      | English                                                                                                                |  |
| 5    | Housing & mounting                   |      | Flush mounting housing and capable of sustaining in harsh environmental condition                                      |  |
| 6    | Relay auxiliary voltage              | V    | Minimum range of 88V to 250V DC and minimum range of 115V to 230V AC                                                   |  |
| 7    | Operating frequency                  | Hz   | 50Hz, $\pm 5\%$                                                                                                        |  |
| 8    | Current transformer requirement      |      |                                                                                                                        |  |
| 8.1  | No of Inputs                         | Nos. | 8 (4 for Double Busbar arrangement)                                                                                    |  |
| 8.2  | Nominal current                      | A    | Operable in 1A and 5A (User settable)                                                                                  |  |
| 8.3  | Minimum continuous current capacity  | A    | 3 *Nominal current                                                                                                     |  |
| 8.4  | Thermal withstand capacity           | A    | 100*Nominal current for at least 1s                                                                                    |  |
| 9    | Voltage transformer requirement      |      |                                                                                                                        |  |
| 9.1  | No of Inputs                         | Nos. | 6 (For Line VT & Bus VT)                                                                                               |  |
| 9.2  | Nominal voltage                      | V AC | 110                                                                                                                    |  |
| 9.3  | Minimum continuous withstand voltage | V AC | 220                                                                                                                    |  |
| 10   | Binary input module                  |      |                                                                                                                        |  |
| 10.1 | Minimum number of inputs             | Nos. | 10 (programmable)<br>(Should be increased as per the scheme design)                                                    |  |
| 10.2 | Minimum operating range              | V    | 110V DC ( $\pm 20\%$ tolerance)                                                                                        |  |
| 11   | Binary output module                 |      |                                                                                                                        |  |
| 11.1 | Minimum number of outputs            | Nos. | 20 (minimum 8 Nos high speed trip output and 2 Nos watchdog outputs)<br>(Should be increased as per the scheme design) |  |
| 11.2 | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                                                               |  |
| 11.3 | Minimum continuous current capacity  | A    | 5                                                                                                                      |  |
| 11.4 | Short time withstand capacity        | A    | 10A for at least 1s                                                                                                    |  |
| 11.5 | Maximum operating time               | ms   | 5ms & 2ms for high speed contact                                                                                       |  |
| 12   | Number of LEDs                       | Nos. | 15 (programmable)<br>(Should be increased as per the scheme design)                                                    |  |
| 13   | HMI                                  |      | Front mounted, should be suitable to                                                                                   |  |

|      |                                                                                        |        |                                                                                                                                                                                                                                                                              |  |
|------|----------------------------------------------------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|      |                                                                                        |        | access all functions, settings and stored records without external computer                                                                                                                                                                                                  |  |
| 14   | Software requirement                                                                   |        | 1. Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>2. Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license |  |
| 15   | GPS Time synchronization                                                               | Yes/No | Yes                                                                                                                                                                                                                                                                          |  |
| 16   | Communication interface                                                                |        |                                                                                                                                                                                                                                                                              |  |
| 16.1 | Standard protocol                                                                      |        | IEC 61850 (have to be able to communicate to IEC 61850 base Substation Automation System)                                                                                                                                                                                    |  |
| 16.2 | Ethernet speed and connector                                                           |        | 100Mbps, RJ45 plug connector/RS232 serial connector as front port                                                                                                                                                                                                            |  |
| 16.3 | Protection communication                                                               |        | Should be suitable for multiplexed, routed switched or dedicated fiber optic communication                                                                                                                                                                                   |  |
| 16.4 | Binary input transfer                                                                  |        | Should be able to transfer at least 8Nos binary signals between the IEDs                                                                                                                                                                                                     |  |
| 17   | Main protection function                                                               |        | Line differential protection                                                                                                                                                                                                                                                 |  |
| 17.1 | Tripping options                                                                       |        | Single and/or three phases                                                                                                                                                                                                                                                   |  |
| 17.2 | Number of parameters setting groups                                                    | Nos    | Minimum 4 (Independently settable)                                                                                                                                                                                                                                           |  |
| 17.3 | Pre-configuration                                                                      |        | For all basic functions                                                                                                                                                                                                                                                      |  |
| 17.4 | Differential characteristics                                                           |        | Restrained biased characteristics with charging current compensations                                                                                                                                                                                                        |  |
| 17.5 | Harmonics blocking                                                                     |        | 2nd and 5th harmonics                                                                                                                                                                                                                                                        |  |
| 17.6 | CT summation                                                                           |        | Internal CT summation facility should be available for 1 and ½ CB arrangement                                                                                                                                                                                                |  |
| 17.7 | Emergency protection (Should be enabled in case of differential communication failure) |        | Impedance protection with at least 4 mho/quadrilateral zone setting options, PSB, SOTF, VTFF and all scheme communication features <sup>1</sup>                                                                                                                              |  |
| 17.8 | Display options                                                                        |        | There must be provision of displaying restraining and differential current on the HMI                                                                                                                                                                                        |  |

<sup>1</sup>PUTT, POTT, CB Echo logic, Weak infeed echo logic, DTT, Zone-1 extension etc.

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|       |                                                       |        |                                                                                                                                                                      |  |
|-------|-------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 17.9  | Tripping time                                         |        | Instantaneous                                                                                                                                                        |  |
| 17.10 | Protected distance                                    |        | Should be able to protect at least 150km of line and further facility of extending protected line length in the relay should be provided                             |  |
| 18    | Back up protection function                           |        | Instantaneous/delayed, directional/non-directional, over current and earth fault                                                                                     |  |
| 19    | Control functions                                     |        | Synchrocheck and 1P/3P auto-reclose for single and multi CB arrangements (1 set for Double busbar arrangement)                                                       |  |
| 20    | Monitoring functions                                  |        |                                                                                                                                                                      |  |
| 20.1  | Fuse failure supervision, current circuit supervision | Yes/No | Yes                                                                                                                                                                  |  |
| 20.2  | U, I, P, Q, S, f, PF monitoring                       | Yes/No | Yes                                                                                                                                                                  |  |
| 20.3  | Event records and oculographic disturbance records    |        | Event recorder should keep at least 20Nos previous records and disturbance recorder should handle at least 8Nos analogue channels and at least 24Nos binary channels |  |
| 21    | Tripping and indication logics                        |        | Programmable                                                                                                                                                         |  |
| 22    | Standards                                             |        | Should conform IEC-60255 in all aspects                                                                                                                              |  |
| 23    | Type test certificate                                 |        | Should be provided                                                                                                                                                   |  |

### 7.3 **Transformer Differential Protection (3 Winding):**

| No. | Description                                | Unit | Minimum Requirements                                                                                                                   | Guaranteed |
|-----|--------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------|------------|
|     |                                            |      | Data                                                                                                                                   |            |
| 1   | Manufacturer                               |      | ABB/SIEMENS/GE/SEL or equivalent. (Switzerland/Sweden/Germany/UK/USA/France or from other eligible countries with equivalent quality). |            |
| 2   | Country of Origin (Place of Manufacturing) |      |                                                                                                                                        |            |
| 3   | Relay Identification                       |      |                                                                                                                                        |            |
| 3.1 | Relay Type & model                         |      | Insert (Main-01 & Main-02 shall be from different manufacturer)                                                                        |            |
| 3.2 | Relay Software version                     |      | Should be filled up by bidder                                                                                                          |            |

|      |                                      |      |                                                                                                                        |  |
|------|--------------------------------------|------|------------------------------------------------------------------------------------------------------------------------|--|
| 3.3  | Relay Hardware version               |      | Should be filled up by bidder                                                                                          |  |
| 4    | Language                             |      | English                                                                                                                |  |
| 5    | Housing & mounting                   |      | Flush mounting housing and capable of sustaining in harsh environmental condition                                      |  |
| 6    | Relay auxiliary voltage              | V    | Minimum range of 88V to 250V DC and minimum range of 115V to 230V AC                                                   |  |
| 7    | Operating frequency                  | Hz   | 50Hz, $\pm 5\%$                                                                                                        |  |
| 8    | Current transformer requirement      |      |                                                                                                                        |  |
| 8.1  | No of Inputs                         | Nos. | 12 (8 Nos for 2 winding Transformer)                                                                                   |  |
| 8.2  | Nominal current                      | A    | Operable in 1A and 5A (User settable)                                                                                  |  |
| 8.3  | Minimum continuous current capacity  | A    | 3 *Nominal current                                                                                                     |  |
| 8.4  | Thermal withstand capacity           | A    | 100*Nominal current for at least 1s                                                                                    |  |
| 9    | Voltage transformer requirement      |      |                                                                                                                        |  |
| 9.1  | No of Inputs                         |      | 6 ( For Line VT & Bus VT)                                                                                              |  |
| 9.2  | Nominal voltage                      | V AC | 110                                                                                                                    |  |
| 9.3  | Minimum continuous withstand voltage | V AC | 220                                                                                                                    |  |
| 10   | Binary input module                  |      |                                                                                                                        |  |
| 10.1 | Minimum number of inputs             | Nos. | 20 (programmable)<br>(Should be increased as per the scheme design)                                                    |  |
| 10.2 | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                                                               |  |
| 11   | Binary output module                 |      |                                                                                                                        |  |
| 11.1 | Minimum number of outputs            | Nos. | 20 (minimum 8 Nos high speed trip output and 2 Nos watchdog outputs)<br>(Should be increased as per the scheme design) |  |
| 11.2 | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                                                               |  |
| 11.3 | Minimum continuous current capacity  | A    | 5                                                                                                                      |  |
| 11.4 | Short time withstand                 | A    | 10A for at least 1s                                                                                                    |  |

|      |                                                 |        |                                                                                                                                                                                                                                                                              |  |
|------|-------------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|      | capacity                                        |        |                                                                                                                                                                                                                                                                              |  |
| 11.5 | Maximum operating time                          | ms     | 10                                                                                                                                                                                                                                                                           |  |
| 12   | Number of LEDs                                  | Nos.   | 15 (programmable)<br>(Should be increased as per the scheme design)                                                                                                                                                                                                          |  |
| 13   | HMI                                             |        | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                             |  |
| 14   | Software requirement                            |        | 1. Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>2. Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any timebounded license. |  |
| 15   | GPS Time synchronization                        | Yes/No | Yes                                                                                                                                                                                                                                                                          |  |
| 16   | Communication interface                         |        |                                                                                                                                                                                                                                                                              |  |
| 16.1 | Standard protocol                               |        | IEC 61850 (have to be able to communicate to IEC 61850 base Substation Automation System)                                                                                                                                                                                    |  |
| 16.2 | Ethernet speed and connector                    |        | 100Mbps, RJ45 plug connector/RS232 serial connector as front port                                                                                                                                                                                                            |  |
| 17   | Main protection function                        |        | Transformer differential protection                                                                                                                                                                                                                                          |  |
| 17.1 | Application                                     |        | For 3 winding and Auto-Transformers<br>(For 2 winding transformer as per requirement)                                                                                                                                                                                        |  |
| 17.2 | Number of parameter setting groups              | Nos.   | Minimum 4 (Independently settable)                                                                                                                                                                                                                                           |  |
| 17.3 | Pre-configuration                               |        | For all basic functions                                                                                                                                                                                                                                                      |  |
| 17.4 | Differential characteristics                    |        | Restrained biased characteristics with stabilization during magnetizing inrush and CT saturation                                                                                                                                                                             |  |
| 17.5 | Harmonics blocking                              |        | 2nd and 5th harmonics                                                                                                                                                                                                                                                        |  |
| 17.6 | CT ratio matching and vector group compensation |        | Internally done, Software based                                                                                                                                                                                                                                              |  |
| 17.7 | CT connection                                   |        | CT connections from each voltage level should be connected individually without external summation                                                                                                                                                                           |  |
| 17.8 | Display options                                 |        | There must be provision of displaying                                                                                                                                                                                                                                        |  |

|       |                                                      |        |                                                                                                                                                                      |  |
|-------|------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|       |                                                      |        | restraining and differential current on the HMI                                                                                                                      |  |
| 17.9  | Tripping time                                        |        | Instantaneous                                                                                                                                                        |  |
| 17.10 | Restricted Earth Fault                               |        | High / low impedance type                                                                                                                                            |  |
| 18    | Back up protection function                          |        | Instantaneous/delayed, directional/non-directional, over current and earth fault                                                                                     |  |
| 19    | Control functions                                    |        | Synchrocheck and 1P/3P auto-reclose for single and multi CB arrangements (1 set for Double Busbar arrangement)                                                       |  |
| 20    | Monitoring functions                                 |        |                                                                                                                                                                      |  |
| 20.1  | U, I, P, Q, S, f, PF monitoring                      | Yes/No | Yes                                                                                                                                                                  |  |
| 20.2  | Event records and oscillographic disturbance records |        | Event recorder should keep at least 20Nos previous records and disturbance recorder should handle at least 8Nos analogue channels and at least 24Nos binary channels |  |
| 21    | Tripping and indication logics                       |        | Should be programmable                                                                                                                                               |  |
| 22    | Standards                                            |        | Should conform IEC-60255 in all aspects                                                                                                                              |  |
| 23    | Type test certificate                                |        | Should be provided                                                                                                                                                   |  |
| 21    | Tripping and indication logics                       |        | Programmable                                                                                                                                                         |  |
| 22    | Standards                                            |        | Should conform IEC-60255 in all aspects                                                                                                                              |  |
| 23    | Type test certificate                                |        | Should be provided                                                                                                                                                   |  |

#### 7.4 Over current and Earth fault protection:

| SL. No. | Description                                | Unit | PGCB's requirements                                                                                                                        | Bidder's Data |
|---------|--------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Manufacturer                               |      | ABB/SIEMENS/GE/SEL or equivalent.<br>(Switzerland/Sweden/Germany/UK/USA/ France or from other eligible countries with equivalent quality). |               |
| 2       | Country of Origin (Place of Manufacturing) |      |                                                                                                                                            |               |
| 3       | Relay Identification                       |      |                                                                                                                                            |               |
| 3.1     | Relay Type & model                         |      | Should be filled up by bidder                                                                                                              |               |

| SL. No. | Description                          | Unit | PGCB's requirements                                                               | Bidder's Data                                |
|---------|--------------------------------------|------|-----------------------------------------------------------------------------------|----------------------------------------------|
| 3.2     | Relay Software version               |      | Should be filled up by bidder                                                     |                                              |
| 3.3     | Relay Hardware version               |      | Should be filled up by bidder                                                     |                                              |
| 4       | Language                             |      | English                                                                           |                                              |
| 5       | Housing & mounting                   |      | Flush mounting housing and capable of sustaining in harsh environmental condition |                                              |
| 6       | Relay auxiliary voltage              | V    | Minimum range of 88V to 250V DC and minimum range of 115V to 230V AC              |                                              |
| 7       | Operating frequency                  | Hz   | 50Hz, $\pm 5\%$                                                                   |                                              |
| 8       | Current transformer requirement      |      |                                                                                   |                                              |
| 8.1     | No of Inputs                         | Nos. | 4                                                                                 |                                              |
| 8.2     | Nominal current                      | A    | Operable in 1A and 5A (User settable)                                             |                                              |
| 8.3     | Minimum continuous current capacity  | A    | 3*Nominal current                                                                 |                                              |
| 8.4     | Thermal withstand capacity           | A    | 100*Nominal current for at least 1s                                               |                                              |
| 9       | Voltage transformer requirement      |      |                                                                                   |                                              |
| 9.1     | No of Inputs                         | Nos  | 4                                                                                 |                                              |
| 9.2     | Nominal voltage                      | V    | 110                                                                               |                                              |
| 9.3     | Minimum continuous withstand voltage | V    | 220                                                                               |                                              |
| 10      | Binary input module                  |      |                                                                                   |                                              |
| 10.1    | Minimum number of inputs             | Nos. | 10 (programmable)                                                                 | Should be increased as per the scheme design |
| 10.2    | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                          |                                              |
| 11      | Binary output module                 |      |                                                                                   |                                              |
| 11.1    | Minimum number of outputs            | Nos. | 10 (minimum 6 Nos high speed trip output and 2 Nos watchdog outputs)              | Should be increased as per the scheme design |
| 11.2    | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                          |                                              |
| 11.3    | Minimum continuous current capacity  | A    | 5                                                                                 |                                              |
| 11.4    | Short time withstand capacity        | A    | 10A for at least 1s                                                               |                                              |
| 11.5    | Maximum operating time               | ms   | 10                                                                                |                                              |
| 12      | Number of LEDs                       | Nos. | 8 (programmable)                                                                  | Should be increased as per the scheme design |

| SL. No. | Description                                                           | Unit | PGCB's requirements                                                                                                                                                                                                                                                           | Bidder's Data |
|---------|-----------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 13      | HMI                                                                   |      | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                              |               |
| 14      | Software requirement                                                  |      | 1. Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>2. Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license. |               |
| 15      | GPS Time synchronization                                              |      | Should be available                                                                                                                                                                                                                                                           |               |
| 16      | Communication interface                                               |      |                                                                                                                                                                                                                                                                               |               |
| 16.1    | Standard protocol                                                     |      | IEC 61850 (have to be able to communicate to IEC 61850 base Substation Automation System)                                                                                                                                                                                     |               |
| 16.2    | Ethernet speed and connector                                          |      | 100Mbps, RJ45 plug connector/RS232 serial connector as front port                                                                                                                                                                                                             |               |
| 17      | Main protection function                                              |      | Instantaneous/delayed, directional/non-directional, over current and earth fault protection with IEC and ANSI/IEEE characteristics curves                                                                                                                                     |               |
| 17.1    | Number of parameter setting groups                                    | Nos. | Minimum 4 (Independently settable)                                                                                                                                                                                                                                            |               |
| 17.2    | Minimum stages in each setting groups for Over-current                | Nos  | 3                                                                                                                                                                                                                                                                             |               |
| 17.3    | Minimum stages in each setting groups for Earth fault                 | Nos  | 3                                                                                                                                                                                                                                                                             |               |
| 17.4    | Pre-configuration                                                     |      | For all basic functions                                                                                                                                                                                                                                                       |               |
| 17.5    | Tripping time                                                         |      | Settable between 0s to 150s                                                                                                                                                                                                                                                   |               |
| 17.6    | Pick up setting range for Time delayed Directional/Non-directional OC | A    | $0.1 \cdot I_n$ to at least $20 \cdot I_n$ (step size 0.01)                                                                                                                                                                                                                   |               |
| 17.7    | Pick up setting range for High set Directional/Non-directional OC     | A    | $0.5 \cdot I_n$ to at least $35 \cdot I_n$ (step size 0.1)                                                                                                                                                                                                                    |               |
| 17.8    | Pick up setting range for Time                                        | A    | $0.01 \cdot I_n$ to at least $20 \cdot I_n$ (step size                                                                                                                                                                                                                        |               |

| SL. No. | Description                                                       | Unit   | PGCB's requirements                                                                                                                                                                                                         | Bidder's Data                       |
|---------|-------------------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
|         | delayed Directional/Non-directional EF                            |        | 0.01)                                                                                                                                                                                                                       |                                     |
| 17.9    | Pick up setting range for High set Directional/Non-directional EF | A      | 0.5*In to at least 35*In (step size 0.1)                                                                                                                                                                                    |                                     |
| 17.10   | TMS setting range for IDMT                                        |        | 0.025 to at least 1.5 (step size 0.025)                                                                                                                                                                                     |                                     |
| 18      | Other protection functions                                        |        | Comprehensive voltage protection functionality including over-voltage, under-voltage, negative sequence overvoltage, residual over-voltage, under-frequency, over-frequency, Rate of Change of Frequency (ROCOF) protection |                                     |
| 19      | Control functions                                                 |        | 2 Sets of Synchrocheck for single and multi CB arrangements if required by PSLD                                                                                                                                             | 1 set for Double Busbar arrangement |
| 20      | Monitoring functions                                              |        |                                                                                                                                                                                                                             |                                     |
| 20.1    | U, I, P, Q, S, f, PF monitoring                                   | Yes/No | Yes                                                                                                                                                                                                                         |                                     |
| 20.2    | Event records and oscillographic disturbance records              |        | Event recorder should keep at least 20Nos previous records and disturbance recorder should handle at least 8Nos analogue channels and at least 24Nos binary channels                                                        |                                     |
| 21      | Tripping and indication logics                                    |        | Should be programmable                                                                                                                                                                                                      |                                     |
| 22      | Standards                                                         |        | Should conform IEC-60255 in all aspects                                                                                                                                                                                     |                                     |
| 23      | Type test certificate                                             |        | Should be provided                                                                                                                                                                                                          |                                     |

#### 7.4 Bay Control Unit (BCU) & Protection Unit (BCPU):

| No. | Description                                | Unit | Minimum Requirements                                                                                                                    | Guaranteed |
|-----|--------------------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------|------------|
|     |                                            |      | Data                                                                                                                                    |            |
| 1   | Manufacturer                               |      | ABB/SIEMENS/GE/SEL or equivalent. (Switzerland/Sweden/Germany/UK/USA/ France or from other eligible countries with equivalent quality). |            |
| 2   | Country of Origin (Place of Manufacturing) |      |                                                                                                                                         |            |
| 3   | Relay Identification                       |      |                                                                                                                                         |            |
| 3.1 | Relay Type & model                         |      | Should be filled up by bidder                                                                                                           |            |
| 3.2 | Relay Software version                     |      | Should be filled up by                                                                                                                  |            |

|      |                                      |     |                                                                                                                         |  |
|------|--------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------|--|
|      |                                      |     | bidder                                                                                                                  |  |
| 3.3  | Relay Hardware version               |     | Should be filled up by bidder                                                                                           |  |
| 4    | Language                             |     | English                                                                                                                 |  |
| 5    | Housing & mounting                   |     | Flush mounting housing and capable of sustaining in harsh environmental condition                                       |  |
| 6    | Relay auxiliary voltage              | V   | Minimum range of 88V to 250V DC and minimum range of 115V to 230V AC                                                    |  |
| 7    | Operating frequency                  | Hz  | 50/60Hz, $\pm 5\%$                                                                                                      |  |
| 8    | Current transformer requirement      |     |                                                                                                                         |  |
| 8.1  | No of Inputs                         | Nos | 4                                                                                                                       |  |
| 8.2  | Nominal current                      | A   | Operable in 1A and 5A                                                                                                   |  |
| 8.3  | Minimum continuous current capacity  | A   | 3*Nominal current                                                                                                       |  |
| 8.4  | Thermal withstand capacity           | A   | 100*Nominal current for at least 1s                                                                                     |  |
| 9    | Voltage transformer requirement      |     |                                                                                                                         |  |
| 9.1  | No of Inputs                         | Nos | 10<br>(For Line voltage and Bus voltages)                                                                               |  |
| 9.2  | Nominal voltage                      | V   | 110                                                                                                                     |  |
| 9.3  | Minimum continuous withstand voltage | V   | 220                                                                                                                     |  |
| 10   | Binary input module                  |     |                                                                                                                         |  |
| 10.1 | Minimum number of inputs             | Nos | 10 (programmable)<br>(Can be increased as per the scheme design)                                                        |  |
| 10.2 | Minimum operating range              | V   | 110V and 220V DC<br>( $\pm 20\%$ tolerance)                                                                             |  |
| 11   | Binary output module                 |     |                                                                                                                         |  |
| 11.1 | Minimum number of outputs            | Nos | 10 (minimum 5 Nos fast operating trip output and 1 Nos watchdog outputs)<br>(Can be increased as per the scheme design) |  |
| 11.2 | Minimum operating range              | V   | 110V and 220V DC<br>( $\pm 20\%$ tolerance)                                                                             |  |
| 11.3 | Minimum continuous current capacity  | A   | 5                                                                                                                       |  |
| 11.4 | Short time withstand capacity        | A   | 10A for at least 1s                                                                                                     |  |
| 11.5 | Maximum operating time               | ms  | 10                                                                                                                      |  |
| 12   | Number of LEDs                       | Nos | 08 (programmable)<br>(Can be increased as per the scheme design)                                                        |  |
| 13   | HMI                                  |     | Front mounted, should                                                                                                   |  |

|      |                                                         |     |                                                                                                                                                                                                                                                                               |  |
|------|---------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|      |                                                         |     | be suitable to issue close & open commands to switching devices through visual animation, access all functions, settings and stored records without external computer                                                                                                         |  |
| 14   | Software requirement                                    |     | 1. Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>2. Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license. |  |
| 15   | GPS Time synchronization                                |     | Should be available                                                                                                                                                                                                                                                           |  |
| 16   | Communication interface                                 |     |                                                                                                                                                                                                                                                                               |  |
| 16.1 | Standard protocol                                       |     | IEC 61850 (have to be able to communicate to IEC 61850 base Substation Automation System)                                                                                                                                                                                     |  |
| 16.2 | Ethernet speed and connector                            |     | 100Mbps, RJ45 plug connector/RS232 serial connector as front port                                                                                                                                                                                                             |  |
| 17   | Main protection function                                |     | Instantaneous/delayed, directional/non-directional, over current and earth fault protection with IEC and ANSI/IEEE characteristics curves                                                                                                                                     |  |
| 17.1 | Number of parameter setting groups                      | Nos | Minimum 4 (Independently settable)                                                                                                                                                                                                                                            |  |
| 17.2 | Minimum stages in each setting groups for Over-current  | Nos | 3                                                                                                                                                                                                                                                                             |  |
| 17.3 | Minimum stages in each setting groups for Earth fault   | Nos | 3                                                                                                                                                                                                                                                                             |  |
| 17.4 | Pre-configuration                                       |     | For all basic functions                                                                                                                                                                                                                                                       |  |
| 17.5 | Tripping time                                           |     | Settable between 0s to 150s                                                                                                                                                                                                                                                   |  |
| 17.6 | Pick up setting range for Time delayed Directional/Non- | A   | $0.1 \cdot I_n$ to at least $20 \cdot I_n$ (step size 0.01)                                                                                                                                                                                                                   |  |

|       |                                                                       |        |                                                                                                                                                                      |  |
|-------|-----------------------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|       | directional OC                                                        |        |                                                                                                                                                                      |  |
| 17.7  | Pick up setting range for High set Directional/Non-directional OC     | A      | 0.5*In to at least 35*In (step size 0.1)                                                                                                                             |  |
| 17.8  | Pick up setting range for Time delayed Directional/Non-directional EF | A      | 0.01*In to at least 20*In (step size 0.01)                                                                                                                           |  |
| 17.9  | Pick up setting range for High set Directional/Non-directional EF     | A      | 0.5*In to at least 35*In (step size 0.1)                                                                                                                             |  |
| 17.10 | TMS setting range for IDMT                                            |        | 0.025 to at least 1.5 (step size 0.025)                                                                                                                              |  |
| 18    | Other protection functions                                            |        | Comprehensive voltage protection functionality including over-voltage, under-voltage, negative sequence overvoltage and residual over-voltage protection             |  |
| 19    | Control functions                                                     |        | Synchrocheck<br>Implementing interlocking logics<br>Execution of close and open command for switching devices coming from SAS and Device HMI                         |  |
| 20    | Monitoring functions                                                  |        |                                                                                                                                                                      |  |
| 20.1  | U, I, P, Q, S, f, PF monitoring                                       | Yes/No | Yes                                                                                                                                                                  |  |
| 20.2  | Event records and oscillographic disturbance records                  |        | Event recorder should keep at least 10Nos previous records and disturbance recorder should handle at least 8Nos analogue channels and at least 16Nos binary channels |  |
| 21    | Tripping and indication logics                                        |        | Should be programmable                                                                                                                                               |  |
| 22    | Standards                                                             |        | Should conform IEC-60255 in all aspects                                                                                                                              |  |
| 23    | Type test certificate                                                 |        | Should be provided                                                                                                                                                   |  |

### 7.5 Frequency Protection

| SL. No. | Description                                | Unit | PGCB's requirements | Bidder's Data |
|---------|--------------------------------------------|------|---------------------|---------------|
| 1       | Manufacturer                               |      |                     |               |
| 2       | Country of Origin (Place of Manufacturing) |      |                     |               |
| 3       | Relay Identification                       |      |                     |               |

| SL. No. | Description                          | Unit | PGCB's requirements                                                                                                                                                                                                                                                    | Bidder's Data |
|---------|--------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 3.1     | Relay Type & model                   |      | Should be filled up by bidder                                                                                                                                                                                                                                          |               |
| 3.2     | Relay Software version               |      | Should be filled up by bidder                                                                                                                                                                                                                                          |               |
| 3.3     | Relay Hardware version               |      | Should be filled up by bidder                                                                                                                                                                                                                                          |               |
| 4       | Language                             |      | English                                                                                                                                                                                                                                                                |               |
| 5       | Housing & mounting                   |      | Flush mounting housing and capable of sustaining in harsh environmental condition                                                                                                                                                                                      |               |
| 6       | Relay auxiliary voltage              | V    | Minimum range of 88V to 250V DC and minimum range of 115V to 230V AC                                                                                                                                                                                                   |               |
| 7       | Operating frequency                  | Hz   | 50/60Hz, $\pm 5\%$                                                                                                                                                                                                                                                     |               |
| 8       | Voltage transformer requirement      |      |                                                                                                                                                                                                                                                                        |               |
| 8.1     | No of Inputs                         |      | 3                                                                                                                                                                                                                                                                      |               |
| 8.2     | Nominal voltage                      | V AC | 110                                                                                                                                                                                                                                                                    |               |
| 8.3     | Minimum continuous withstand voltage | V AC | 220                                                                                                                                                                                                                                                                    |               |
| 9       | Language                             |      | English                                                                                                                                                                                                                                                                |               |
| 10      | Binary input module                  |      |                                                                                                                                                                                                                                                                        |               |
| 10.1    | Minimum number of inputs             | Nos  | 5 (programmable)                                                                                                                                                                                                                                                       |               |
| 10.2    | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                                                                                                                                                                                                               |               |
| 11      | Binary output module                 |      |                                                                                                                                                                                                                                                                        |               |
| 11.1    | Minimum number of outputs            | Nos  | 8                                                                                                                                                                                                                                                                      |               |
| 11.2    | Minimum operating range              | V    | 110V and 220V DC ( $\pm 20\%$ tolerance)                                                                                                                                                                                                                               |               |
| 11.3    | Minimum continuous current capacity  | A    | 5                                                                                                                                                                                                                                                                      |               |
| 11.4    | Short time withstand capacity        | A    | 10A for at least 1s                                                                                                                                                                                                                                                    |               |
| 12      | Number of LEDs                       | Nos  | 8 (programmable)                                                                                                                                                                                                                                                       |               |
| 13      | HMI                                  |      | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                       |               |
| 14      | Software requirement                 |      | Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license |               |
| 15      | GPS Time synchronization             |      | Should be available                                                                                                                                                                                                                                                    |               |
| 16      | Communication interface              |      |                                                                                                                                                                                                                                                                        |               |
| 16.1    | Standard protocol                    |      | IEC 61850 (have to be able to                                                                                                                                                                                                                                          |               |

| SL. No. | Description                                           | Unit   | PGCB's requirements                                                                                                                                                                 | Bidder's Data |
|---------|-------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         |                                                       |        | communicate to IEC 61850 base Substation Automation System)                                                                                                                         |               |
| 16.2    | Ethernet speed and connector                          |        | 100Mbps, RJ45 plug connector/RS232 serial connector as front port                                                                                                                   |               |
| 17      | Frequency protection functions                        |        | Comprehensive frequency protection functionality including over-frequency, under-frequency, frequency rate of change with rate of change of rise and rate of change of fall freely. |               |
| 17.1    | Number of parameter setting groups                    | Nos    | Minimum 4 (Independently settable)                                                                                                                                                  |               |
| 17.2    | Pre-configuration                                     |        | For all basic functions                                                                                                                                                             |               |
| 17.3    | Frequency setting range                               | Hz     | 40 to 60 or higher range (in step size of 0.01Hz)                                                                                                                                   |               |
| 17.4    | Time setting range of U/F and O/F                     | sec    | 0 to 100 or higher range (in step size of 0.01s)                                                                                                                                    |               |
| 17.5    | Setting range of Rate of Change of Frequency (ROCOF)) | Hz/sec | 0.1 to 10 or higher range (in step size of 0.01Hz/sec)                                                                                                                              |               |
| 17.5    | Time setting range of ROCOF                           | sec    | 0 to 50 or higher range (in step size of 0.01s)                                                                                                                                     |               |
| 18      | Event records and oscillographic disturbance records  |        | Event recorder should keep at least 10Nos previous records and disturbance recorder should handle at least 4Nos analogue channels and at least 8Nos binary channels                 |               |
| 19      | Tripping and indication logics                        |        | Should be programmable                                                                                                                                                              |               |
| 20      | Standards                                             |        | Should conform IEC-60255 in all aspects                                                                                                                                             |               |
| 21      | Type test certificate                                 |        | Should be provided                                                                                                                                                                  |               |

### 7.6 Busbar and Breaker Failure Protection

| SL. No. | Description                                | Unit | PGCB's requirements                                                                                                                      | Bidder's Data |
|---------|--------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Manufacturer                               |      | ABB/SIEMENS/GE/SEL or equivalent. (Switzerland/Sweden/Germany/UK/US A/ France or from other eligible countries with equivalent quality). |               |
| 2       | Country of Origin (Place of Manufacturing) |      |                                                                                                                                          |               |
| 3       | Relay Installation                         |      |                                                                                                                                          |               |
| 3.1     | Operating architecture                     |      | Distributed                                                                                                                              |               |
| 3.2     | Number of Central Unit                     | Nos  | 1                                                                                                                                        |               |

| SL. No. | Description                                                  | Unit                            | PGCB's requirements                                                                                                                                                     | Bidder's Data                           |
|---------|--------------------------------------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| 3.3     | Number of Bay Units                                          | Nos                             | As mentioned in Substation Single Line Diagram;<br>For Breaker Failure Protection of Tie CB in 1 and Half CB bus arrangement, stand-alone relays will also be accepted. |                                         |
| 3.4     | Minimum number of Bay Units supported by single Central Unit | Nos                             | 30                                                                                                                                                                      |                                         |
| 4       | Central Unit Requirements                                    |                                 |                                                                                                                                                                         |                                         |
| 4.1     | Relay Type & model                                           |                                 | Should be filled up by bidder                                                                                                                                           |                                         |
| 4.2     | Relay Software version                                       |                                 | Should be filled up by bidder                                                                                                                                           |                                         |
| 4.3     | Relay Hardware version                                       |                                 | Should be filled up by bidder                                                                                                                                           |                                         |
| 4.4     | Language                                                     |                                 | English                                                                                                                                                                 |                                         |
| 4.5     | Housing & mounting                                           |                                 | Flush mounting housing and capable of sustaining in harsh environmental condition                                                                                       |                                         |
| 4.6     | Relay auxiliary voltage                                      | V DC                            | Minimum range of 48V to 250V; with protective fuse                                                                                                                      |                                         |
| 4.7     | Maximum ripple                                               |                                 | ≤15%                                                                                                                                                                    |                                         |
| 4.8     | Operating frequency                                          | Hz                              | 50Hz, ±5%                                                                                                                                                               |                                         |
| 4.9     | Binary Inputs of Central Unit                                |                                 |                                                                                                                                                                         |                                         |
|         | 4.8.1                                                        | Minimum number of binary inputs | Nos.                                                                                                                                                                    | 12 (programmable)                       |
|         | 4.8.2                                                        | Minimum operating range         | V DC                                                                                                                                                                    | Substation nominal DC voltage ±15%      |
|         | 4.8.3                                                        | Operating time                  | ms                                                                                                                                                                      | <1                                      |
| 4.10    | Binary Outputs of Central Unit                               |                                 |                                                                                                                                                                         |                                         |
|         | 4.9.1                                                        | Minimum number of outputs       | Nos.                                                                                                                                                                    | 9                                       |
|         | 4.9.2                                                        | Operating time                  | ms                                                                                                                                                                      | 3                                       |
|         | 4.9.3                                                        | Operating voltage               | V                                                                                                                                                                       | Upto 250 V AC/DC                        |
|         | 4.9.4                                                        | Continuous current capacity     | A                                                                                                                                                                       | 8                                       |
|         | 4.9.5                                                        | Short time current capacity     | A                                                                                                                                                                       | 30A for at least 0.5s                   |
|         | 4.9.6                                                        | Binary output reset response    |                                                                                                                                                                         | Programmable for latched and self reset |
| 4.11    | Number of LEDs                                               | Nos.                            | 20 (programmable)                                                                                                                                                       |                                         |
| 4.12    | HMI                                                          |                                 | Front mounted, should be suitable to access all relevant measurements, alarms, tripping information and switching device information without external computer          |                                         |
| 5       | Bay Unit Requirements                                        |                                 |                                                                                                                                                                         |                                         |
| 5.1     | Relay Type & model                                           |                                 | Should be filled up by bidder                                                                                                                                           |                                         |
| 5.2     | Relay Software version                                       |                                 | Should be filled up by bidder                                                                                                                                           |                                         |

| SL. No. | Description                        | Unit                                | PGCB's requirements                                                                                                                                            | Bidder's Data                           |
|---------|------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| 5.3     | Relay Hardware version             |                                     | Should be filled up by bidder                                                                                                                                  |                                         |
| 5.4     | Language                           |                                     | English                                                                                                                                                        |                                         |
| 5.5     | Housing & mounting                 |                                     | Flush mounting housing and capable of sustaining in harsh environmental condition                                                                              |                                         |
| 5.6     | Relay auxiliary voltage            | V DC                                | Minimum range of 48V to 250V                                                                                                                                   |                                         |
| 5.7     | Maximum ripple                     |                                     | ≤15%                                                                                                                                                           |                                         |
| 5.8     | Operating frequency                | Hz                                  | 50Hz, ±5%                                                                                                                                                      |                                         |
| 5.9     | Binary Inputs of Bay Unit          |                                     |                                                                                                                                                                |                                         |
|         | 5.8.1                              | Minimum number of binary inputs     | Nos.                                                                                                                                                           | 12 (programmable)                       |
|         | 5.8.2                              | Minimum operating range             | V DC                                                                                                                                                           | Substation nominal DC voltage ±15%      |
|         | 5.8.3                              | Operating time                      | ms                                                                                                                                                             | <1                                      |
| 5.10    | Binary Outputs of Bay Unit         |                                     |                                                                                                                                                                |                                         |
|         | 5.9.1                              | Minimum number of outputs           | Nos.                                                                                                                                                           | 16                                      |
|         | 5.9.2                              | Operating time                      | ms                                                                                                                                                             | 3                                       |
|         | 5.9.3                              | Operating voltage                   | V                                                                                                                                                              | Upto 250 V AC/DC                        |
|         | 5.9.4                              | Continuous current capacity         | A                                                                                                                                                              | 8                                       |
|         | 5.9.5                              | Short time current capacity         | A                                                                                                                                                              | 30A for at least 0.5s                   |
| 5.11    | 5.9.6                              | Binary output reset response        |                                                                                                                                                                | Programmable for latched and self reset |
|         | CT requirements of Bay Unit        |                                     |                                                                                                                                                                |                                         |
|         | 5.10.1                             | No of CT Inputs                     | Nos.                                                                                                                                                           | 4                                       |
|         | 5.10.2                             | Nominal current                     | A                                                                                                                                                              | Operable in 1A and 5A (User settable)   |
|         | 5.10.3                             | Minimum continuous current capacity | A                                                                                                                                                              | 4*Nominal current                       |
|         | 5.10.4                             | Thermal withstand capacity          | A                                                                                                                                                              | 100*Nominal current for at least 1s     |
| 5.12    | 5.10.5                             | Burden per phase                    | VA                                                                                                                                                             | ≤0.2                                    |
|         |                                    |                                     |                                                                                                                                                                |                                         |
| 5.12    | Number of LEDs                     | Nos.                                | 8 (programmable)                                                                                                                                               |                                         |
| 5.13    | HMI                                |                                     | Front mounted, should be suitable to access all relevant measurements, alarms, tripping information and switching device information without external computer |                                         |
| 5.14    | Test socket                        |                                     | Should be installed in the front side of the panel with each Bay Unit                                                                                          |                                         |
| 5.15    | Supply of applicable test plug     | Nos                                 | 2 Nos for each substation                                                                                                                                      |                                         |
| 6       | Communication interface & Software |                                     |                                                                                                                                                                |                                         |
| 6.1     | Software requirement               |                                     | 1. Should be able to configure, operate                                                                                                                        |                                         |

| SL. No. | Description                                                          | Unit | PGCB's requirements                                                                                                                                                                                                                   | Bidder's Data |
|---------|----------------------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         |                                                                      |      | and monitor with user friendly engineering and disturbance handling tool.<br>2. Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license. |               |
| 6.2     | GPS Time synchronization                                             |      | Should be available                                                                                                                                                                                                                   |               |
| 6.3     | Standard protocol                                                    |      | IEC 61850 (have to be able to communicate to IEC 61850 base Substation Automation System)                                                                                                                                             |               |
| 6.4     | Ethernet speed and connector                                         |      | 100Mbps, RJ45 plug connector/RS232 serial connector as front port                                                                                                                                                                     |               |
| 6.5     | Protection communication interface                                   |      |                                                                                                                                                                                                                                       |               |
| 6.5.1   | Type of communication                                                |      | Optical fibre                                                                                                                                                                                                                         |               |
| 6.5.2   | Number of cores per Bay Unit                                         | Nos  | 2                                                                                                                                                                                                                                     |               |
| 6.5.3   | Core/sheath diameter                                                 |      | 62.5/125µm (multi-mode)                                                                                                                                                                                                               |               |
| 6.5.4   | Maximum permissible attenuation                                      | dB   | 5                                                                                                                                                                                                                                     |               |
| 6.5.5   | Minimum supported transmission length                                | m    | 1200                                                                                                                                                                                                                                  |               |
| 7       | Protection Functions                                                 |      |                                                                                                                                                                                                                                       |               |
| 7.1     | Main protection function                                             |      |                                                                                                                                                                                                                                       |               |
| 7.1.1   | Required function                                                    |      | Highly reliable low-impedance based busbar differential protection                                                                                                                                                                    |               |
| 7.1.2   | Evaluation criteria                                                  |      | Differential current with restrain feature<br>Directional current comparison method                                                                                                                                                   |               |
| 7.1.3   | Evaluation method                                                    |      | Phase segregated                                                                                                                                                                                                                      |               |
| 7.1.4   | Through-fault stability during CT saturation                         |      | Must be complied                                                                                                                                                                                                                      |               |
| 7.1.5   | CT switching/Busbar selection                                        |      | Must be done internally                                                                                                                                                                                                               |               |
| 7.1.6   | Minimum fault current pick-up setting                                | A    | 0.2 to 4 x I <sub>N</sub> in step size of 0.01                                                                                                                                                                                        |               |
| 7.1.7   | Differential restraining characteristics slope setting               |      | 0.5 to 0.8; in step size of 0.05                                                                                                                                                                                                      |               |
| 7.1.8   | Differential current alarms<br>Current setting<br>Time delay setting |      | 5 to 50% of minimum pick-up in steps of 5%<br>2 to 10s in steps of 1s                                                                                                                                                                 |               |
| 7.1.9   | Isolator alarm time delay                                            |      | 0.5 to 90s                                                                                                                                                                                                                            |               |

| SL. No. | Description                      |                                                                      | Unit | PGCB's requirements                                                                 | Bidder's Data                                |
|---------|----------------------------------|----------------------------------------------------------------------|------|-------------------------------------------------------------------------------------|----------------------------------------------|
|         | 7.1.10                           | Typical tripping time                                                |      | 20 to 30ms at IDiff/IRest $\geq 5$                                                  |                                              |
|         | 7.1.11                           | Settable CT ratio per feeder                                         |      | 50 to 10,000/1A                                                                     |                                              |
| 7.2     | Check zone criterion             |                                                                      |      | Should be available                                                                 |                                              |
|         | 7.2.1                            | Minimum fault current pick-up setting                                | A    | 0.2 to 4 x IN in step size of 0.01                                                  |                                              |
|         | 7.2.2                            | Differential restraining characteristics slope setting               |      | 0 to 0.8; in step size of 0.05                                                      |                                              |
|         | 7.2.3                            | Settable CT ratio per feeder                                         |      | 50 to 10,000/1A                                                                     |                                              |
| 7.3     | Additional protection function 1 |                                                                      |      |                                                                                     |                                              |
|         | 7.3.1                            | Required function                                                    |      | TEE-point differential protection (for 1 and half CB bus arrangement only)          | Not applicable for Double busbar arrangement |
|         | 7.3.2                            | Evaluation criteria                                                  |      | Differential current with restrain feature<br>Directional current comparison method |                                              |
|         | 7.3.3                            | Evaluation method                                                    |      | Phase segregated                                                                    |                                              |
|         | 7.3.4                            | Through-fault stability during CT saturation                         |      | Must be complied                                                                    |                                              |
|         | 7.3.5                            | CT switching/selection                                               |      | Must be done internally                                                             |                                              |
|         | 7.3.6                            | Minimum fault current pick-up setting                                | A    | 0.2 to 4 x IN in step size of 0.01                                                  |                                              |
|         | 7.3.7                            | Differential restraining characteristics slope setting               |      | 0.5 to 0.8; in step size of 0.05                                                    |                                              |
|         | 7.3.8                            | Differential current alarms<br>Current setting<br>Time delay setting |      | 5 to 50% of minimum pick-up in steps of 5%<br>2 to 10s in steps of 1s               |                                              |
|         | 7.3.9                            | Isolator alarm time delay                                            |      | 0.5 to 90s                                                                          |                                              |
|         | 7.3.10                           | Typical tripping time                                                |      | 20 to 30ms at IDiff/IRest $\geq 5$                                                  |                                              |
|         | 7.3.11                           | Settable CT ratio per feeder                                         |      | 50 to 10,000/1A                                                                     |                                              |
| 7.4     | Additional protection function 2 |                                                                      |      |                                                                                     |                                              |
|         | 7.4.1                            | Required function                                                    |      | Breaker failure protection                                                          |                                              |
|         | 7.4.2                            | Current setting range                                                |      | 0.1 to 2 x IN in step size of 0.1 x IN                                              |                                              |
|         | 7.4.3                            | Measurement accuracy                                                 |      | $\pm 5\%$                                                                           |                                              |
|         | 7.4.4                            | Tripping logic                                                       |      | Should be available for minimum 2                                                   |                                              |

| SL. No. | Description                              | Unit                                    | PGCB's requirements                                                                                                                                                 | Bidder's Data |
|---------|------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         | 4                                        |                                         | (two) stages: re-trip and remote trip                                                                                                                               |               |
|         | 7.4.5                                    | Setting range of re-trip timer (t1)     | ms<br>10 to 5,000ms in steps of 10ms                                                                                                                                |               |
|         | 7.4.6                                    | Setting range of remote trip timer (t2) | ms<br>10 to 5,000ms in steps of 10ms                                                                                                                                |               |
|         | 7.4.7                                    | Remote trip pulse duration              | ms<br>100 to 2,000ms in steps on 10ms                                                                                                                               |               |
| 7.5     | Additional protection function 3         |                                         |                                                                                                                                                                     |               |
|         | 7.5.1                                    | Required function                       | End-fault protection                                                                                                                                                |               |
|         | 7.5.2                                    | Current setting range                   | 0.1 to 2 x IN in step size of 0.1 x IN                                                                                                                              |               |
|         | 7.5.3                                    | Timer setting range                     | ms<br>100 to 10,000ms in steps of 100ms                                                                                                                             |               |
| 7.6     | Selective Tripping & Blocking options    |                                         |                                                                                                                                                                     |               |
|         | 7.6.1                                    | Selective tripping                      | Should be provided based of statuses of switching devices                                                                                                           |               |
|         | 7.6.2                                    | Selective blocking                      | Should be available for differential current alarm, switching object alarm, measurement abnormality, communication failure between Central Unit and Bay Unit        |               |
|         | 7.6.3                                    | Forced blocking                         | Should be provided with selector switches installed in the panel for following options: BBP block, BFP block, EFP block, Output contacts block, All functions block |               |
| 7.7     | Pre-configuration                        |                                         | For all basic functions with respect to the complete Single Line Diagram of the substation                                                                          |               |
| 8       | Monitoring & Supervision functions       |                                         |                                                                                                                                                                     |               |
| 8.1     | Current measurement                      |                                         | For all feeders and all phases, Differential Current, Restraining current                                                                                           |               |
| 8.2     | Switching object monitoring              |                                         | Should be available                                                                                                                                                 |               |
| 8.3     | Self supervision system                  |                                         | Should be available for Central Unit and Bay Units                                                                                                                  |               |
| 8.4     | Event records                            |                                         | Event recorder should keep at least 100 events in each bay unit and at least 1000 events in Central Unit                                                            |               |
| 8.5     | Time stamp of event records              |                                         | Date and time with 1ms accuracy                                                                                                                                     |               |
| 8.6     | Disturbance records                      |                                         | Should be available with wave shapes of all current measurements and at least 32 binary inputs and outputs for each bay unit.                                       |               |
| 8.7     | Sampling frequency of disturbance record | Hz                                      | At least 2400                                                                                                                                                       |               |

| SL. No. | Description                    | Unit | PGCB's requirements                                                       | Bidder's Data |
|---------|--------------------------------|------|---------------------------------------------------------------------------|---------------|
| 9       | Tripping and indication logics |      | Should be programmable                                                    |               |
| 10      | Standards                      |      | Should conform IEC-60255 in all aspects                                   |               |
| 11      | Type test certificate          |      | Should be provided                                                        |               |
| 12      | Environmental requirements     |      |                                                                           |               |
| 12.1    | Temperature                    |      |                                                                           |               |
| 12.1.1  | Operation                      | °C   | -10 to +55                                                                |               |
| 12.1.2  | Storage and Transport          | °C   | -40 to +85                                                                |               |
| 12.2    | Climate tests                  |      |                                                                           |               |
| 12.2.1  | Cold                           |      | -25°C/16h                                                                 |               |
| 12.2.2  | Dry heat                       |      | +70°C/16h                                                                 |               |
| 12.2.3  | Damp heat                      |      | -25°C to +70°C, 1°C, 2 cycles                                             |               |
| 12.2.4  | Damp heat (long time)          |      | +40°C, 93% relative humidity/4 days                                       |               |
| 12.3    | Insulation resistance tests    |      | >100 MOhm @0.5kV                                                          |               |
| 12.4    | Dielectric tests               |      | 2kV AC or 3kV DC/1 min<br>1kV AC or 1.4kV DC/1 min (across open contacts) |               |
| 12.5    | Impulse test                   |      | 1.2/50 μS/0.5 Joule, 5kV AC                                               |               |

#### 7.6 Trip circuit supervision relays (4 Nos for 2 feeders):

| SL. No. | Description                | Unit | PGCB's requirements                                                                                                                        | Bidder's Data |
|---------|----------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Manufacturer's name        |      | ABB/SIEMENS/GE/SEL or equivalent.<br>(Switzerland/Sweden/Germany/UK/USA/ France or from other eligible countries with equivalent quality). |               |
| 2       | Country of Origin          |      |                                                                                                                                            |               |
| 3       | Type, model                |      | Should be filled up by bidder                                                                                                              |               |
| 4       | Supervision mode           |      | Pre-close and post-close                                                                                                                   |               |
| 5       | Maximum operating time     | ms   | 70                                                                                                                                         |               |
| 6       | Rated voltage              | V DC | 100-125 or higher range                                                                                                                    |               |
| 7       | Minimum threshold voltage  | V DC | 25% lower than the nominal voltage                                                                                                         |               |
| 8       | Thermal rating of the coil | %    | 120% of the rated voltage, continuous                                                                                                      |               |
| 9       | Maximum coil burden        | W    | 20W at rated voltage                                                                                                                       |               |

| SL. No. | Description                       | Unit | PGCB's requirements                     | Bidder's Data |
|---------|-----------------------------------|------|-----------------------------------------|---------------|
| 10      | Number of Normally Open contacts  | Nos  | As required for standard scheme         |               |
| 11      | Number of Normally Close contacts | Nos  | As required for standard scheme         |               |
| 12      | Standards                         |      | Should conform IEC-60255 in all aspects |               |

**7.7 Self Reset trip relays (as required for providing standard number of tripping and annunciation signals):**

| SL. No. | Description                                | Unit | PGCB's requirements                                                                                                                        | Bidder's Data |
|---------|--------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Manufacturer's name                        |      | ABB/SIEMENS/GE/SEL or equivalent.<br>(Switzerland/Sweden/Germany/UK/USA/ France or from other eligible countries with equivalent quality). |               |
| 2       | Country of Origin                          |      |                                                                                                                                            |               |
| 3       | Type, model                                |      | Should be filled up by bidder                                                                                                              |               |
| 4       | Reset mechanism                            |      | Self reset                                                                                                                                 |               |
| 5       | Maximum operating time                     | ms   | 10                                                                                                                                         |               |
| 6       | Maximum reset time                         | ms   | 20                                                                                                                                         |               |
| 7       | Rated voltage                              | V DC | 100-125 or higher range                                                                                                                    |               |
| 8       | Minimum threshold voltage                  | V DC | 35% lower than the nominal voltage                                                                                                         |               |
| 9       | Minimum Rated capacity of relay contacts   |      | AC 1250VA with maxima of 5A and 300V<br>DC 1250W with maxima of 5A and 300V                                                                |               |
| 10      | Minimum thermal capacity of relay contacts |      | AC 7500VA with maxima of 30A and 300V<br>DC 7500W with maxima of 30A and 300V                                                              |               |
| 11      | Number of Normally Open contacts           | Nos  | As required for standard scheme                                                                                                            |               |
| 12      | Number of Normally Close contacts          | Nos  | As required for standard scheme                                                                                                            |               |
| 13      | Standards                                  |      | Should conform IEC-60255 in all aspects                                                                                                    |               |

**7.8 Self Reset trip relays (as required for providing standard number of tripping and annunciation signals):**

| SL. No. | Description                                | Unit | PGCB's requirements                                                                                                                        | Bidder's Data |
|---------|--------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Manufacturer's name                        |      | ABB/SIEMENS/GE/SEL or equivalent.<br>(Switzerland/Sweden/Germany/UK/USA/ France or from other eligible countries with equivalent quality). |               |
| 2       | Country of Origin                          |      |                                                                                                                                            |               |
| 3       | Type, model                                |      | Should be filled up by bidder                                                                                                              |               |
| 4       | Reset mechanism                            |      | Hand reset                                                                                                                                 |               |
| 5       | Maximum operating time                     | ms   | 10                                                                                                                                         |               |
| 6       | Rated voltage                              | V DC | 100-125 or higher range                                                                                                                    |               |
| 7       | Minimum threshold voltage                  | V DC | 35% lower than the nominal voltage                                                                                                         |               |
| 8       | Minimum Rated capacity of relay contacts   |      | AC 1250VA with maxima of 5A and 300V<br>DC 1250W with maxima of 5A and 300V                                                                |               |
| 9       | Minimum thermal capacity of relay contacts |      | AC 7500VA with maxima of 30A and 300V<br>DC 7500W with maxima of 30A and 300V                                                              |               |
| 10      | Number of Normally Open contacts           | Nos  | As required for standard scheme                                                                                                            |               |
| 11      | Number of Normally Close contacts          | Nos  | As required for standard scheme                                                                                                            |               |
| 12      | Standards                                  |      | Should conform IEC-60255 in all aspects                                                                                                    |               |

**7.9 Test Socket**

| No. | Description                                                                                           | Unit | Minimum Requirements | Bidder's Data |
|-----|-------------------------------------------------------------------------------------------------------|------|----------------------|---------------|
|     |                                                                                                       |      | Data                 |               |
| 1.1 | Manufacturer                                                                                          |      |                      |               |
| 1.2 | Country of origin                                                                                     |      |                      |               |
| 1.3 | Type<br>Line main 1 and 2<br>Line back-up and bus coupler<br>Transformer main 1 and 2<br>Bay unit BBF |      | Insert               |               |

|       |                                                                                                                                                                                                                                                                                                                                                                    |           |          |  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------|--|
|       | Distance protection                                                                                                                                                                                                                                                                                                                                                |           |          |  |
| 1.4   | Standards                                                                                                                                                                                                                                                                                                                                                          |           | IEC      |  |
| 1.5   | Each protection device must have its own test socket                                                                                                                                                                                                                                                                                                               |           | Yes      |  |
| 1.6   | Test socket must obtain safe online protection testing and maintaining, and performing whole tripping test with following AR                                                                                                                                                                                                                                       |           | Yes      |  |
| 1.7   | Test socket should have enough contacts to:<br>Short-circuit current inputs from CT's<br>Isolate voltage inputs from VT's<br>Isolate trip circuit for each phase separately<br>Isolate CB close command<br>Isolate signalling voltage<br>Inhibit breaker failure initialising<br>Inhibit sending of communication signal<br>Allow functional testing of protection |           | Yes      |  |
| 1.8   | Socket should be designed for 4 mm banana plugs access                                                                                                                                                                                                                                                                                                             |           | Yes      |  |
| 2.2.1 | Number of outputs                                                                                                                                                                                                                                                                                                                                                  | NO/N<br>C | Min. 2/2 |  |

**7.10 Energy Meter (3-phase, 4-wire, 3-element, Numerical Indoor Type with Power Quality Monitoring):**

| SL. No. | Description         | Unit | PGCB's requirements                                        | Bidder's data |
|---------|---------------------|------|------------------------------------------------------------|---------------|
| 1       | Manufacturer's name |      | CEWE/Elster/Landis+Gyr/EDMI/SEL                            |               |
| 2       | Country of Origin   |      | France/UK/USA/Switzerland/Sweden/Germany/EU                |               |
| 3       | Model               |      | Should be filled up by bidder                              |               |
| 4       | Meter type          |      | Numerical, programmable, multi-function                    |               |
| 5       | Display language    |      | English                                                    |               |
| 6       | Connection type     |      | CT/VT operated, 3-phase, 4 wires, solidly grounded neutral |               |
| 7       | Installation        |      | Indoor installation                                        |               |
| 8       | Type of socket      |      | To be mentioned                                            |               |
| 9       | Number of element   | Nos  | 3 (three)                                                  |               |
| 10      | Number of terminals | Nos  | At least 10 (ten)                                          |               |
| 11      | Current range       | A    | 1 to 10, user programmable                                 |               |

| SL. No. | Description                                 | Unit     | PGCB's requirements                                                                                                                                                                                          | Bidder's data |
|---------|---------------------------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 12      | Starting Current                            | A        | 0.1% of nominal                                                                                                                                                                                              |               |
| 13      | Continuous Thermal current rating           | A        | 1.5*In or higher                                                                                                                                                                                             |               |
| 14      | Short time thermal rating                   | A        | 10*In or higher for 1sec                                                                                                                                                                                     |               |
| 15      | Voltage range                               | V AC     | 50 to 82.5 (P-N) or higher range, Burden-10MΩ                                                                                                                                                                |               |
| 16      | Overload voltage                            | V AC     | 1.3*Vn, continuous                                                                                                                                                                                           |               |
| 17      | Burden                                      |          |                                                                                                                                                                                                              |               |
|         | 17.1 Current Circuit                        | VA/phase | < 0.1 @ 1A, < 0.5 @ 5A                                                                                                                                                                                       |               |
|         | 17.2 Voltage Circuit (with auxiliary power) | VA/phase | < 0.1                                                                                                                                                                                                        |               |
|         | 17.3 Voltage Circuit (with self power)      | VA/phase | < 6VA                                                                                                                                                                                                        |               |
| 18      | Auxiliary supply range                      |          | Dual Power Supply:<br>80V to 240V AC/DC or higher range<br>Self Power with VT voltage (80V to 130V AC)                                                                                                       |               |
| 19      | Operating frequency                         |          | 50Hz (±5%)                                                                                                                                                                                                   |               |
| 20      | Measuring mode                              |          | True 4 quadrant                                                                                                                                                                                              |               |
| 21      | Accuracy class                              |          | 0.2S for kWh, 0.5 for kVARh                                                                                                                                                                                  |               |
| 22      | Losses at nominal load                      |          | To be mentioned                                                                                                                                                                                              |               |
| 23      | Local communication                         |          | DLMS, RS232/RS485/Ethernet                                                                                                                                                                                   |               |
| 24      | Remote communication                        |          | Standard metering protocol, MODBUS;<br>Communication facility to Network Control Center should be available                                                                                                  |               |
| 25      | Software interfacing facility with PC       |          | Should be available                                                                                                                                                                                          |               |
| 26      | Software requirement                        |          | Should be able to configure and monitor with user friendly PC-based tool.<br>2. Necessary software for configuration and parameterization has to be supplied free of cost and without any time-bound license |               |
| 27      | Password protection                         |          | Should be available for programming, configuration and read out meter data                                                                                                                                   |               |
| 28      | Meter sealing condition                     |          | Hermatically or Ultrasonic welded                                                                                                                                                                            |               |
| 29      | Display options                             |          | Built-in HMI LCD display, configurable display, including meter ID, power quadrant display                                                                                                                   |               |
| 30      | Integration period                          |          | 30 (thirty) minutes                                                                                                                                                                                          |               |
|         | Resetting period                            |          | 1 (one) month                                                                                                                                                                                                |               |
|         | Cumulative MD transfer                      |          | Built-in                                                                                                                                                                                                     |               |

| SL. No. | Description                      | Unit | PGCB's requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Bidder's data |
|---------|----------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         | Cycle Timing device              |      | Built-in                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |
| 31      | Normal display list              |      | Complete LCD test, Present date, Present time<br>Current billing total kWh-Del, Current billing total kWh-Rec<br>Current billing total kVARh-(Q1+Q4), Current billing total kVARh-(Q2+Q3)<br>Current billing maximum kW-Del, Current billing maximum kW- Del Date, Current billing maximum kW-Del Time, Current billing cumulative kW-Del<br>Current billing maximum kW-Rec, Current billing maximum kW-Rec Date, Current billing maximum kW-Rec Time, Current billing cumulative kW-Rec<br>Phase A voltage, Phase B voltage, Phase C voltage<br>Phase A current, Phase B current, Phase C current<br>Phase A voltage angle, Phase B voltage angle, Phase C voltage angle<br>Phase A current angle, Phase B current angle, Phase C current angle<br>System PF-arithmetic, Line frequency |               |
| 32      | Alternate mode display list      |      | Complete LCD test, Present date, Present time<br>Current billing total kWh-Del, Current billing total kWh-Rec<br>Current billing total kVARh-(Q1+Q4), Current billing total kVARh-(Q2+Q3)<br>System PF-arithmetic, Line frequency                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |
| 33      | Online testing facility          |      | Should be available with online CT shorting facility with security sealing provision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |
| 34      | Data storage                     |      | At least 32MB of nonvolatile memory for data storage and capable of simultaneously record 4 load profile recorders x 8 channels for at least 90days at 30 minute intervals.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |               |
| 35      | Data logging and event recording |      | Should be available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
| 36      | In built clock                   |      | Should be available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
| 37      | Provision of GPS synchronization |      | Should be available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |
| 38      | Additional Features              |      | Power Quality Measurement (At least 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               |

| SL. No. | Description                                         | Unit  | PGCB's requirements                                                                                                                                                                                                                                                          | Bidder's data |
|---------|-----------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         |                                                     |       | GB of memory, 192 channels of LDP, 24kHz waveform, 600 VSSI summary events, Wave View, Flicker, Power Harmonics and Interharmonics, Total Harmonic Distortion)<br>Necessary software for accessing the mentioned features should be provided without any time-bound license. |               |
| 39      | Environment requirement                             |       |                                                                                                                                                                                                                                                                              |               |
|         | 39.1 Ingress protection                             |       | IP54 or better                                                                                                                                                                                                                                                               |               |
|         | 39.2 Operating temperature                          |       | -10°C to +60°C                                                                                                                                                                                                                                                               |               |
|         | 39.3 Storage temperature                            |       | -40°C to +80°C                                                                                                                                                                                                                                                               |               |
|         | 39.4 Humidity range                                 |       | 0% to 95%, non-condensing                                                                                                                                                                                                                                                    |               |
| 40      | Weight of the meter                                 |       | To be mentioned                                                                                                                                                                                                                                                              |               |
| 41      | Dimension of the meter                              |       | To be mentioned                                                                                                                                                                                                                                                              |               |
| 42      | Outline, drawing and leaflets                       |       | To be provided                                                                                                                                                                                                                                                               |               |
| 43      | Performance curves for balanced and unbalanced load |       | To be mentioned                                                                                                                                                                                                                                                              |               |
| 44      | Year of manufacture                                 |       | To be mentioned                                                                                                                                                                                                                                                              |               |
| 45      | Minimum Battery Service life and shelf life         | Years | 10 (ten) & 15 (fifteen) respectively                                                                                                                                                                                                                                         |               |
| 46      | Meter service life                                  | Years | 15 (fifteen)                                                                                                                                                                                                                                                                 |               |
| 47      | Reference standard                                  |       | Relevant ANSI/IEC standard                                                                                                                                                                                                                                                   |               |
| 48      | Warranty                                            | Years | 3 (three)                                                                                                                                                                                                                                                                    |               |
| 49      | Type test certificate                               |       | Should be provided                                                                                                                                                                                                                                                           |               |

### 7.11 Overall Fault Clearance Times

| No. | Description                                    | Unit | Minimum Requirements | Guaranteed |
|-----|------------------------------------------------|------|----------------------|------------|
|     |                                                |      | Data                 |            |
| 1   | 230 kV Busbar Faults:                          |      |                      |            |
|     | Main protection relay operating time           | ms   | Insert               |            |
|     | Auxiliary and tripping relay time (where used) | ms   | Insert               |            |
|     | Circuit breaker time                           | ms   | Insert               |            |
|     | Total                                          | ms   | Insert               |            |
| 2   | 132 kV Busbar Faults:                          |      |                      |            |
|     | Main protection relay operating time           | ms   | Insert               |            |
|     | Auxiliary and tripping relay time (where used) | ms   | Insert               |            |
|     | Circuit breaker time                           | ms   | Insert               |            |

|   |                                            |    |        |  |
|---|--------------------------------------------|----|--------|--|
|   | Total                                      | ms | Insert |  |
| 3 | 230/135/34.5 kV Transformer Faults:        |    |        |  |
|   | Main protection relay operating time       | ms | Insert |  |
|   | Auxiliary and tripping relay time          | ms | Insert |  |
|   | Circuit breaker time                       | ms | Insert |  |
|   | Total                                      | ms | Insert |  |
| 4 | 132/34.5 kV Transformer Faults:            |    |        |  |
|   | Main protection relay operating time       | ms | Insert |  |
|   | Auxiliary and tripping relay time          | ms | Insert |  |
|   | Circuit breaker time                       | ms | Insert |  |
|   | Total                                      | ms | Insert |  |
| 5 | 230 kV Line Faults:                        |    |        |  |
|   | Distance protection maximum operating time | ms | Insert |  |
|   | Permissive scheme time delay               | ms | Insert |  |
|   | Auxiliary relay time (where used)          | ms | Insert |  |
|   | Circuit breaker time                       | ms | Insert |  |
|   | Total                                      | ms | Insert |  |
| 6 | 132 kV Line Faults:                        |    |        |  |
|   | Distance protection maximum operating time | ms | Insert |  |
|   | Permissive scheme time delay               | ms | Insert |  |
|   | Auxiliary relay time (where used)          | ms | Insert |  |
|   | Circuit breaker time                       | ms | Insert |  |
|   | Total                                      | ms | Insert |  |

#### 7.12 **Multi-Phase Auto reclose**

| No. | Description                     | Unit | Minimum Requirements | Guaranteed |
|-----|---------------------------------|------|----------------------|------------|
|     |                                 |      | Data                 |            |
| 1.  | Manufacturer's name and address |      | Insert               |            |
| 2.  | Country of origin               |      | Insert               |            |
| 3.  | Type                            |      | Insert               |            |
| 4.  | Model No.                       |      | Insert               |            |
| 5.  | Standard                        |      | Insert               |            |
| 6.  | Single phase auto reclose       |      | Insert               |            |
| 7.  | Three phase auto reclose        |      | Insert               |            |
| 8.  | Multi-phase auto reclose        |      | Insert               |            |
| 9.  | Main -1 Protection              |      | Insert               |            |
| 10. | Main -2 Protection              |      | Insert               |            |

#### 7.13 **Front Panel Annunciation for OHL & Power Transformers (Optional)**

| No. | Description | Minimum Requirements |      | Guaranteed |
|-----|-------------|----------------------|------|------------|
|     |             | Unit                 | Data |            |

|      |                                                              |  |            |  |
|------|--------------------------------------------------------------|--|------------|--|
|      | Front Panel annunciation for OHL & TR                        |  |            |  |
| 1.1  | Panel mounting                                               |  | Yes        |  |
| 1.2  | Number of inputs                                             |  | Min. 16    |  |
| 1.3  | Contact type                                                 |  | NO/NC      |  |
| 1.4  | Galvanic isolation                                           |  | Yes        |  |
| 1.5  | Self-monitoring<br>via front indication<br>via relay contact |  | Yes        |  |
| 1.6  | Response delay time                                          |  | Adjustable |  |
| 1.7  | Bright LED technology                                        |  | Yes        |  |
| 1.8  | Audible device output                                        |  | Yes        |  |
| 1.9  | Lamp test button                                             |  | Yes        |  |
| 1.10 | Acknowledgement button                                       |  | Yes        |  |
| 1.11 | Horn acknowledgement button                                  |  | Yes        |  |
|      | Overall compliance with the requirements (yes/no)            |  |            |  |

The front panel annunciation must be parameterised, configured and delivered as per Engineer's requirements.

**7.14 Front Panel Annunciation for Control Room (Optional)**

| No.  | Description                                                  | Minimum Requirements |            | Guaranteed |
|------|--------------------------------------------------------------|----------------------|------------|------------|
|      |                                                              | Unit                 | Data       |            |
|      | Front Panel annunciation for Control Room                    |                      |            |            |
| 1.1  | Panel mounting                                               |                      | Yes        |            |
| 1.2  | Number of inputs                                             |                      | Min. 48    |            |
| 1.3  | Contact type                                                 |                      | NO/NC      |            |
| 1.4  | Galvanic isolation                                           |                      | Yes        |            |
| 1.5  | Self-monitoring<br>via front indication<br>via relay contact |                      | Yes        |            |
| 1.6  | Response delay time                                          |                      | Adjustable |            |
| 1.7  | Bright LED technology                                        |                      | Yes        |            |
| 1.8  | Audible device output                                        |                      | Yes        |            |
| 1.9  | Lamp test button                                             |                      | Yes        |            |
| 1.10 | Acknowledgement button                                       |                      | Yes        |            |
| 1.11 | Horn acknowledgement button                                  |                      | Yes        |            |
|      | Overall compliance with the requirements (yes/no)            |                      |            |            |

The front panel annunciation must be parameterised, configured and delivered as per Engineer's requirements.

**7.15 SCADA Server**

| No.   | Description                    | Minimum Requirements |                     | Guaranteed |
|-------|--------------------------------|----------------------|---------------------|------------|
|       |                                | Unit                 | Data                |            |
| 14261 | SCADA Server                   |                      |                     |            |
| 1.1   | Manufacturer                   |                      | Insert              |            |
| 1.2   | Country of origin              |                      | Insert              |            |
| 1.3   | Type                           |                      | Insert              |            |
| 1.4   | Standards                      |                      | IEC                 |            |
| 1.5   | Type of housing                |                      | Industrial 19" rack |            |
| 2     | Characteristics                |                      |                     |            |
| 2.1   | Auxiliary supply voltage       |                      |                     |            |
| 2.1.1 | Rated auxiliary supply voltage | V d.c.               | 110 ±15 %           |            |
| 2.1.2 | Dual power supply              |                      | Yes                 |            |
| 2.2   | Processor type                 |                      | Insert              |            |
| 2.3   | Processor clock                | GHz                  | Insert              |            |

| No.      | Description                                       | Minimum Requirements |           | Guaranteed |
|----------|---------------------------------------------------|----------------------|-----------|------------|
|          |                                                   | Unit                 | Data      |            |
| 2.4      | Memory type                                       |                      | Insert    |            |
| 2.5      | Memory capacity                                   | MB                   | Insert    |            |
| 2.6      | Video display adapter type                        |                      | Insert    |            |
| 2.7      | Video display adapter memory                      |                      | Insert    |            |
| 2.8      | Hard disc type                                    |                      | Insert    |            |
| 2.9      | Rotating hard disc                                | Yes/No               | Insert    |            |
| 2.10     | Hard disc capacity                                | GB                   | Insert    |            |
| 2.11     | Number of hard discs                              | pcs.                 | Insert    |            |
| 2.12     | RAID controller type                              |                      | Insert    |            |
| 2.13     | DVD RW type                                       |                      | Insert    |            |
| 2.14     | Serial interface RS232                            |                      | Yes       |            |
| 2.15     | Number of serial interfaces                       |                      | Min. 2    |            |
| 2.16     | Fast Ethernet network interface card type         |                      | Insert    |            |
| 2.17     | Number of fast Ethernet network interface cards   | pcs.                 | 4         |            |
| 2.18     | Fans                                              | Yes/No               | Insert    |            |
| 2.19     | Monitor 19"                                       | pcs.                 | 1         |            |
| 2.19.1   | Manufacturer                                      |                      | Insert    |            |
| 2.19.2   | Country of origin                                 |                      | Insert    |            |
| 2.19.3   | Type                                              |                      | TFT       |            |
| 2.19.4   | Standards                                         |                      | IEC       |            |
| 2.19.5   | Supply voltage                                    |                      |           |            |
| 2.19.5.1 | Rated auxiliary supply voltage                    | V a.c.               | 110 ±15 % |            |
| 2.19.5.2 | Power consumption                                 | W                    | Insert    |            |
| 2.20     | Vertical frequency                                | Hz                   | Insert    |            |
| 2.21     | Max. resolution                                   |                      | Insert    |            |
|          | Overall compliance with the requirements (yes/no) |                      |           |            |

#### 7.16 SCADA servers must be in hot-standby redundant configuration.

## Substation Automation System

| No. | Description                                                                                                                                                                                                                                                               | Minimum Requirements   |                                                                                                                                             | Guaranteed |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------|
|     |                                                                                                                                                                                                                                                                           | Unit                   | Data                                                                                                                                        |            |
| 1.  | General                                                                                                                                                                                                                                                                   |                        |                                                                                                                                             |            |
| 1.1 | Standards                                                                                                                                                                                                                                                                 |                        |                                                                                                                                             |            |
|     | Test Cab: Damp heat, steady state<br>Test Db: Damp heat, cycle (12h + 12h cycle)<br>Digital I/O, Analogue I/O dielectric Tests<br>Digital I/O, Surge withstand test<br>Radio interference test<br>Transient fast burst test<br>Static Discharge<br>Electromagnetic fields |                        | IEC 60068-2-78<br>IEC 60068-2-30<br>IEC 60255-27<br>IEC 61000-4-5<br>IEC 60870-3/Class 2<br>IEC 61000-4-4<br>IEC 61000-4-2<br>IEC 61000-4-3 |            |
| 1.2 | Number of years of proven field experience of offered system.<br>(Note: proof of experience should be furnished. The components used in the offered system and those with field experience should be the same)                                                            | Year                   | 5                                                                                                                                           |            |
| 1.3 | Design life of substation Automation System                                                                                                                                                                                                                               | Year                   | 15                                                                                                                                          |            |
| 1.4 | Manufacturers quality assurance system                                                                                                                                                                                                                                    |                        | ISO 9001/9002 or equivalent                                                                                                                 |            |
| 1.5 | Dimensions of cubicle<br>Width<br>Depth<br>Height<br>Floor load                                                                                                                                                                                                           | mm<br>mm<br>mm<br>N/m2 | Insert<br>Insert<br>Insert<br>Max 600                                                                                                       |            |
| 1.6 | Temperature range (min/max)                                                                                                                                                                                                                                               | oC                     | 0/50                                                                                                                                        |            |
| 1.7 | Relative humidity                                                                                                                                                                                                                                                         | %                      | 93                                                                                                                                          |            |
| 1.8 | Intelligent Electronic Devices (IED's)                                                                                                                                                                                                                                    |                        |                                                                                                                                             |            |
|     | -serial communication interface included?                                                                                                                                                                                                                                 | Yes/No                 | Yes                                                                                                                                         |            |
|     | -Protection & Control IED's connected same bus?                                                                                                                                                                                                                           | Yes/No                 | Yes                                                                                                                                         |            |
|     | - self monitoring                                                                                                                                                                                                                                                         | Yes/No                 | Yes                                                                                                                                         |            |
|     | - display of measured values                                                                                                                                                                                                                                              | Yes/No                 | Yes                                                                                                                                         |            |
|     | -remote parameterization                                                                                                                                                                                                                                                  | Yes/No                 | Yes                                                                                                                                         |            |
|     | -disturbance record upload and analysis                                                                                                                                                                                                                                   | Yes/No                 | Yes                                                                                                                                         |            |

| No.  | Description                                                                                                                        | Minimum Requirements |               | Guaranteed |
|------|------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------|------------|
|      |                                                                                                                                    | Unit                 | Data          |            |
| 1.9  | Availability Calculation shall be furnished for each equipment as well as for the entire system.                                   | Yes/No               | Yes           |            |
| 1.10 | The main part of the system, HMI, Gateway, IED shall be furnished with dual communication port against any failure.                | Yes/No               | Yes           |            |
| 1.11 | SNTP server shall provide GPS time-sync information to all communication (HMI, Gateway, IED) and the system shall be synchronized. | Hz                   | Yes           |            |
| 1.12 | Ethernet switch shall have dual system topology not to lose entire system with single switching system failure.                    | V                    | Yes           |            |
| 2.   | Station Level Equipment:                                                                                                           |                      |               |            |
| 2.1  | Station Controller                                                                                                                 |                      | Industrial PC |            |
| 2.2  | MTBF (Mean time between Failures)                                                                                                  | Hours                | 50000         |            |
| 2.3  | Station computer shall have dual connection to Ethernet switch as redundant (hot, standby)                                         | Yes/No               | Yes           |            |
| 2.4  | Hot standby take over time                                                                                                         | Seconds              | Yes           |            |
| 2.5  | Dual Wide Monitor each HMI (over 25")                                                                                              | Yes/No               | Yes           |            |
| 2.6  | Single wide screen                                                                                                                 | Yes/No               | Yes           |            |
| 2.7  | Number of years of proven field experience of offered software                                                                     | years                | 5             |            |
| 2.8  | Operating System                                                                                                                   |                      | Windows       |            |

| No. | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Minimum Requirements |                                                                                                                                | Guaranteed |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------|------------|
|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Unit                 | Data                                                                                                                           |            |
| 2.9 | i) All standard picture as per spec included in HMI<br>ii) Process Status Display & Command Procedures<br>iii) Event processing as per spec<br>iv) Alarm processing as per spec<br>v) Reports as per spec<br>vi) Trend Display as per spec<br>vii) Graphical fault information receiving function<br>viii) Disturbance & Fault recording and analysis with graphical format<br>ix) User Authority levels as per spec<br>x) System supervision & monitoring as per spec<br>xi) Automatic sequence control as per spec | Yes/No               | Yes                                                                                                                            |            |
| 3   | Gateway to National Load dispatch Center                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |                                                                                                                                |            |
| 3.2 | Number of years of proven field experience of offered unit<br>Insulation tests<br>Fast disturbance tests<br>Industrial environment<br>Industrial grade hardware with no moving parts<br>(PC based gateway is not accepted)<br>Design life of offered equipment<br>Redundant communication channel<br>Redundant CPU<br>Redundant DC/DC Supply                                                                                                                                                                         | %                    | 5Yrs<br><br>IEC 60255-27<br>IEC 61000-4-4, Class 4<br>EN61000-6-4<br>Yes<br><br>15 Yrs<br>Yes<br>Yes<br>Yes<br>50000Hrs<br>Yes |            |
| 3.  | Station Bus:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                      |                                                                                                                                |            |
| 3.1 | Physical Medium                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                      | Glass fibre optic                                                                                                              |            |
| 3.2 | Each communication devices shall have dual connection, hot and standby.                                                                                                                                                                                                                                                                                                                                                                                                                                              | Yes/No               | Yes                                                                                                                            |            |
| 4.  | Inter-bay Bus: Physical Medium                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                      | Glass fibre optic                                                                                                              |            |
| 5   | Printer server: MTBF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Hours                | 200000                                                                                                                         |            |
| 6   | Hard Copy colour Printer: MTBF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Hours                | 180000                                                                                                                         |            |
| 7   | Master Clock – GPS (Global Positioning System) Receiver: MTBF                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Hours                | 150000                                                                                                                         |            |

| No.  | Description                                                                                                      | Minimum Requirements |                          | Guaranteed |
|------|------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------|------------|
|      |                                                                                                                  | Unit                 | Data                     |            |
| 8    | Bay control Unit - HV                                                                                            |                      |                          |            |
| 8.1  | Number of years of proven field experience of offered unit                                                       |                      | 5                        |            |
| 8.2  | Separate Bay controller unit provided for each bay & feeder                                                      | Yes/No               | Yes                      |            |
| 8.3  | Type of bay controller offered HV/MV                                                                             |                      | HV                       |            |
| 8.4  | Select Before Operate with Open Execute & Close                                                                  | Yes/No               | Yes                      |            |
| 8.5  | Single bit dependence                                                                                            | Yes/No               | Yes                      |            |
| 8.6  | Interlocking, bay & Station wide                                                                                 | Yes/No               | Yes                      |            |
| 8.7  | Synchro check function<br>Maximum Voltage difference<br>Maximum Frequency difference<br>Maximum Phase difference | Specify Range        | Insert                   |            |
| 8.8  | Double command blocking                                                                                          | Yes/No               | Yes                      |            |
| 8.9  | Independent settable parameter groups                                                                            | No                   | 4                        |            |
| 8.10 | Local Display Unit                                                                                               | Yes/No               | Yes                      |            |
| 8.11 | Sequence of event recorder<br>Events<br>Time resolution                                                          | Nos<br>msec          | 256<br>1                 |            |
| 8.12 | Disturbance recording file transfer function                                                                     | Yes/No               | Yes                      |            |
| 8.13 | Comtrade file generation function of Disturbance Recorder                                                        | Yes/No               | Yes                      |            |
| 8.14 | IED shall have dual connection to Ethernet switch (hot & standby)                                                | Yes/No               | Yes                      |            |
| 8.15 | Comprehensive self-supervision                                                                                   | Yes/No               | Yes                      |            |
| 8.16 | Battery free backup of events and disturbance records                                                            | Yes/No               | Yes                      |            |
| 8.17 | Insulation tests                                                                                                 | Standard             | IEC 60255-27             |            |
| 8.18 | Fast disturbance tests                                                                                           | Standard             | IEC 61000-4-4, Class 4   |            |
| 8.19 | Temperature range: IED's<br>Operation<br>Transport and storage                                                   | oC<br>oC             | -10 to +50<br>-10 to +50 |            |
| 8.20 | Relative humidity:<br>Operating max./min<br>Transport and storage                                                | %<br>%               | 93<br>93                 |            |
| 9    | Back up control mimic –HV (400kV)                                                                                |                      |                          |            |

| No.   | Description                                                                                                                                                           | Minimum Requirements |                           | Guaranteed |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------|------------|
|       |                                                                                                                                                                       | Unit                 | Data                      |            |
| 9.1   | Control functionality:<br>Control of breaker as well as all<br>isolators/earthing switch<br>(Control functionality should not be<br>affected if bay controller fails) | Yes/No               | Yes                       |            |
| 9.2   | Key-Locked                                                                                                                                                            | Yes/No               | Yes                       |            |
| 9.3   | Interlock override function                                                                                                                                           | Yes/No               | Yes                       |            |
| 9.4   | Separate backup control mimic<br>provided for each bay & feeder                                                                                                       | Yes/No               | Yes                       |            |
| 10    | Bay control Unit - MV                                                                                                                                                 |                      |                           |            |
| 10.1  | Number of years of proven field<br>experience of offered unit                                                                                                         |                      | 5                         |            |
| 10.2  | Separate Bay controller unit provided<br>for each bay & feeder                                                                                                        | Yes/No               | Yes                       |            |
| 10.3  | Type of bay controller offered HV/MV                                                                                                                                  |                      | HV                        |            |
| 10.4  | Select Before Operate with Open<br>Execute & Close                                                                                                                    | Yes/No               | Yes                       |            |
| 10.5  | Single bit dependence                                                                                                                                                 | Yes/No               | Yes                       |            |
| 10.6  | Interlocking, bay & Station wide                                                                                                                                      | Yes/No               | Yes                       |            |
| 10.7  | Synchro check function<br>Maximum Voltage difference<br>Maximum Frequency difference<br>Maximum Phase difference                                                      | Specify<br>Range     | Insert                    |            |
| 10.8  | Double command blocking                                                                                                                                               | Yes/No               | Yes                       |            |
| 10.9  | Independent settable parameter groups                                                                                                                                 | No                   | 4                         |            |
| 10.10 | Local Display Unit                                                                                                                                                    | Yes/No               | Yes                       |            |
| 10.11 | Sequence of event recorder<br>Events<br>Time resolution                                                                                                               | Nos<br>msec          | 256<br>1                  |            |
| 10.12 | Disturbance recording file transfer<br>function                                                                                                                       | Yes/No               | Yes                       |            |
| 10.13 | Comtrade file generation function of<br>Disturbance Recorder                                                                                                          | Yes/No               | Yes                       |            |
| 10.14 | IED shall have dual connection to<br>Ethernet switch (hot & standby)                                                                                                  | Yes/No               | Yes                       |            |
| 10.15 | Comprehensive self-supervision                                                                                                                                        | Yes/No               | Yes                       |            |
| 10.16 | Battery free backup of events and<br>disturbance records                                                                                                              | Yes/No               | Yes                       |            |
| 10.17 | Insulation tests                                                                                                                                                      | Standard             | IEC 60255-27              |            |
| 10.18 | Fast disturbance tests                                                                                                                                                | Standard             | IEC 61000-4-4,<br>Class 4 |            |

| No.   | Description                                                                                                                                                           | Minimum Requirements |                          | Guaranteed |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------|------------|
|       |                                                                                                                                                                       | Unit                 | Data                     |            |
| 10.19 | Temperature range: IED's<br>Operation<br>Transport and storage                                                                                                        | oC<br>oC             | -10 to +50<br>-10 to +50 |            |
| 10.20 | Relative humidity:<br>Operating max./min<br>Transport and storage                                                                                                     | %<br>%               | 93<br>93                 |            |
| 11    | Back up control mimic –HV (400kV)                                                                                                                                     |                      |                          |            |
| 11.1  | Control functionality:<br>Control of breaker as well as all<br>isolators/earthing switch<br>(Control functionality should not be<br>affected if bay controller fails) | Yes/No               | Yes                      |            |
| 11.2  | Key-Locked                                                                                                                                                            | Yes/No               | Yes                      |            |
| 11.3  | Interlock override function                                                                                                                                           | Yes/No               | Yes                      |            |
| 11.4  | Separate backup control mimic<br>provided for each bay & feeder                                                                                                       | Yes/No               | Yes                      |            |
| 12    | Bay control Unit - LV                                                                                                                                                 |                      |                          |            |
| 12.1  | Number of years of proven field<br>experience of offered unit                                                                                                         |                      | 5                        |            |
| 12.2  | Separate Bay controller unit provided<br>for each bay & feeder                                                                                                        | Yes/No               | Yes                      |            |
| 12.3  | Type of bay controller offered HV/MV                                                                                                                                  |                      | HV                       |            |
| 12.4  | Select Before Operate with Open<br>Execute & Close                                                                                                                    | Yes/No               | Yes                      |            |
| 12.5  | Single bit dependence                                                                                                                                                 | Yes/No               | Yes                      |            |
| 12.6  | Interlocking, bay & Station wide                                                                                                                                      | Yes/No               | Yes                      |            |
| 12.7  | Synchro check function<br>Maximum Voltage difference<br>Maximum Frequency difference<br>Maximum Phase difference                                                      | Specify<br>Range     | Insert                   |            |
| 12.8  | Double command blocking                                                                                                                                               | Yes/No               | Yes                      |            |
| 12.9  | Independent settable parameter groups                                                                                                                                 | No                   | 4                        |            |
| 12.10 | Local Display Unit                                                                                                                                                    | Yes/No               | Yes                      |            |
| 12.11 | Sequence of event recorder<br>Events<br>Time resolution                                                                                                               | Nos<br>msec          | 256<br>1                 |            |
| 12.12 | Disturbance recording file transfer<br>function                                                                                                                       | Yes/No               | Yes                      |            |
| 12.13 | Comtrade file generation function of<br>Disturbance Recorder                                                                                                          | Yes/No               | Yes                      |            |
| 12.14 | IED shall have dual connection to<br>Ethernet switch (hot & standby)                                                                                                  | Yes/No               | Yes                      |            |

| No.   | Description                                                       | Minimum Requirements |                          | Guaranteed |
|-------|-------------------------------------------------------------------|----------------------|--------------------------|------------|
|       |                                                                   | Unit                 | Data                     |            |
| 12.15 | Comprehensive self-supervision                                    | Yes/No               | Yes                      |            |
| 12.16 | Battery free backup of events and disturbance records             | Yes/No               | Yes                      |            |
| 12.17 | Insulation tests                                                  | Standard             | IEC 60255-27             |            |
| 12.18 | Fast disturbance tests                                            | Standard             | IEC 61000-4-4, Class 4   |            |
| 12.19 | Temperature range: IED's<br>Operation<br>Transport and storage    | oC<br>oC             | -10 to +50<br>-10 to +50 |            |
| 12.20 | Relative humidity:<br>Operating max./min<br>Transport and storage | %<br>%               | 93<br>93                 |            |
| 13    | Back up control mimic –HV (400kV)                                 |                      | DELETED                  |            |
| 14    | System Performance:                                               |                      |                          |            |
| 14.1  | Exchange of display (First reaction)                              | second               | < 1                      |            |
| 14.2  | Presentation of a binary change in the process display            | second               | < 0.5                    |            |
| 14.3  | Presentation of an analogue change in the process display         | second               | < 1                      |            |
| 14.4  | From order to process output                                      | second               | < 0.5                    |            |
| 14.5  | From order to updated of display                                  | second               | < 1.5                    |            |

### 7.17 Operator Workstation

| No.   | Description                    | Minimum Requirements |           | Guaranteed |
|-------|--------------------------------|----------------------|-----------|------------|
|       |                                | Unit                 | Data      |            |
| 1     | Operator Workstation           |                      |           |            |
| 1.1   | Manufacturer                   |                      | Insert    |            |
| 1.2   | Country of origin              |                      | Insert    |            |
| 1.3   | Type                           |                      | Insert    |            |
| 1.4   | Standards                      |                      | IEC       |            |
| 1.5   | Type of housing                |                      | Insert    |            |
| 2     | Characteristics                |                      |           |            |
| 2.1   | Auxiliary supply voltage       |                      |           |            |
| 2.1.1 | Rated auxiliary supply voltage | V d.c.               | 110 ±15 % |            |
| 2.2   | Processor type                 |                      | Insert    |            |

| No.      | Description                                       | Minimum Requirements |                      | Guaranteed |
|----------|---------------------------------------------------|----------------------|----------------------|------------|
|          |                                                   | Unit                 | Data                 |            |
| 2.3      | Processor clock                                   | GHz                  | Insert               |            |
| 2.4      | Memory type                                       |                      | Insert               |            |
| 2.5      | Memory capacity                                   | MB                   | Insert               |            |
| 2.6      | Video display adapter type                        |                      | Dual head capability |            |
| 2.7      | Video display adapter memory                      | MB                   | Insert               |            |
| 2.8      | Hard disc type                                    |                      | Insert               |            |
| 2.9      | Rotating hard disc                                | Yes/No               | Insert               |            |
| 2.10     | Hard disc capacity                                | GB                   | Insert               |            |
| 2.11     | Number of hard discs                              | pcs.                 | Insert               |            |
| 2.12     | RAID controller type                              |                      | Insert               |            |
| 2.13     | DVD RW type                                       |                      | Insert               |            |
| 2.14     | Sound card type                                   |                      | Insert               |            |
| 2.15     | Fast Ethernet network interface card type         |                      | Insert               |            |
| 2.16     | Number of fast Ethernet network interface cards   | pcs.                 | 4                    |            |
| 2.17     | Fans                                              | Yes/No               | Insert               |            |
| 2.18     | Monitor 24"                                       | pcs.                 | 2                    |            |
| 2.18.1   | Manufacturer                                      |                      | Insert               |            |
| 2.18.2   | Country of origin                                 |                      | Insert               |            |
| 2.18.3   | Type                                              |                      | TFT                  |            |
| 2.18.4   | Standards                                         |                      | IEC                  |            |
| 2.18.5   | Supply voltage                                    |                      |                      |            |
| 2.18.5.1 | Rated auxiliary supply voltage                    | V a.c.               | 110 ±15 %            |            |
| 2.18.5.2 | Power consumption                                 | W                    | Insert               |            |
| 2.19     | Visible diagonal                                  | "                    | Insert               |            |
| 2.20     | Vertical frequency                                | Hz                   | Insert               |            |
| 2.21     | Max. resolution                                   |                      | Insert               |            |
|          | Overall compliance with the requirements (yes/no) |                      |                      |            |

### 7.18 Printer

| No. | Description | Minimum Requirements |      | Guaranteed |
|-----|-------------|----------------------|------|------------|
|     |             | Unit                 | Data |            |

|       |                                                   |          |              |  |
|-------|---------------------------------------------------|----------|--------------|--|
| 14263 | Printer / Code number: 14263                      |          |              |  |
| 1.1   | Manufacturer                                      |          | Insert       |  |
| 1.2   | Model                                             |          | Insert       |  |
| 1.3   | Country of origin                                 |          | Insert       |  |
| 1.4   | Standards                                         |          | IEC / ISO    |  |
| 2     | Characteristics                                   |          |              |  |
| 2.1   | Auxiliary supply voltage                          |          |              |  |
| 2.1.1 | Rated auxiliary supply voltage                    | V d.c.   | 110 ±15 %    |  |
| 2.2   | Type                                              |          | Colour laser |  |
| 2.3   | Format                                            |          | A4           |  |
| 2.4   | Resolution                                        | dpi      | Insert       |  |
| 2.5   | Memory                                            | MB       | Insert       |  |
| 2.6   | Parallel port                                     | Yes/No   | Insert       |  |
| 2.7   | Fast Ethernet port                                |          | Yes          |  |
| 2.8   | USB port                                          | Yes/No   | Insert       |  |
| 2.9   | Minimum speed                                     | Page/min | Insert       |  |
|       | Overall compliance with the requirements (yes/no) |          |              |  |

**7.19 Monitoring Workstation**

| No.    | Description                                     | Minimum Requirements |           | Guaranteed |
|--------|-------------------------------------------------|----------------------|-----------|------------|
|        |                                                 | Unit                 | Data      |            |
|        | Monitoring Workstation                          |                      |           |            |
| 1.1    | Manufacturer                                    |                      | Insert    |            |
| 1.2    | Country of origin                               |                      | Insert    |            |
| 1.3    | Type                                            |                      | Insert    |            |
| 1.4    | Standards                                       |                      | IEC       |            |
| 1.5    | Type of housing                                 |                      | Insert    |            |
| 2      | Characteristics                                 |                      |           |            |
| 2.1    | Auxiliary supply voltage                        |                      |           |            |
| 2.1.1  | Rated auxiliary supply voltage                  | V d.c.               | 110 ±15 % |            |
| 2.2    | Processor type                                  |                      | Insert    |            |
| 2.3    | Processor clock                                 | GHz                  | Insert    |            |
| 2.4    | Memory type                                     |                      | Insert    |            |
| 2.5    | Memory capacity                                 | MB                   | Insert    |            |
| 2.6    | Video display adapter type                      |                      | Insert    |            |
| 2.7    | Video display adapter memory                    | MB                   | Insert    |            |
| 2.8    | Hard disc type                                  |                      | Insert    |            |
| 2.9    | Rotating hard disc                              | Yes/No               | Insert    |            |
| 2.10   | Hard disc capacity                              | GB                   | Insert    |            |
| 2.11   | Number of hard discs                            | pcs.                 | Insert    |            |
| 2.12   | RAID controller type                            |                      | Insert    |            |
| 2.13   | DVD RW type                                     |                      | Insert    |            |
| 2.14   | Sound card type                                 |                      | Insert    |            |
| 2.15   | Serial interface RS232                          |                      | Yes       |            |
| 2.16   | Fast Ethernet network interface card type       |                      | Insert    |            |
| 2.17   | Number of fast Ethernet network interface cards | pcs.                 | 1         |            |
| 2.18   | Fans                                            | Yes/No               | Insert    |            |
| 2.19   | Monitor 24"                                     | pcs.                 | 1         |            |
| 2.19.1 | Manufacturer                                    |                      | Insert    |            |
| 2.19.2 | Country of origin                               |                      | Insert    |            |
| 2.19.3 | Type                                            |                      | TFT       |            |
| 2.19.4 | Standards                                       |                      | IEC       |            |
| 2.19.5 | Supply voltage                                  |                      |           |            |

| No.      | Description                                       | Minimum Requirements |           | Guaranteed |
|----------|---------------------------------------------------|----------------------|-----------|------------|
|          |                                                   | Unit                 | Data      |            |
| 2.19.5.1 | Rated auxiliary supply voltage                    | V a.c.               | 110 ±15 % |            |
| 2.19.5.2 | Power consumption                                 | W                    | Insert    |            |
| 2.20     | Vertical frequency                                | Hz                   | Insert    |            |
| 2.21     | Max. resolution                                   |                      | Insert    |            |
|          | Overall compliance with the requirements (yes/no) |                      |           |            |

## 7.20 Time Synchronization Device

| No.   | Description                                       | Minimum Requirements |           | Guaranteed |
|-------|---------------------------------------------------|----------------------|-----------|------------|
|       |                                                   | Unit                 | Data      |            |
| 14271 | Time Synchronization Device / Code number: 14271  |                      |           |            |
| 1.1   | Manufacturer                                      |                      | Insert    |            |
| 1.2   | Country of origin                                 |                      | Insert    |            |
| 1.3   | Type                                              |                      | Insert    |            |
| 1.4   | Standards                                         |                      | IEC       |            |
| 2     | Characteristics                                   |                      |           |            |
| 2.1   | Auxiliary supply voltage                          |                      |           |            |
| 2.1.1 | Rated auxiliary supply voltage                    | V d.c.               | 110 ±15 % |            |
| 2.2   | Rack mounting case                                |                      | Insert    |            |
| 2.3   | Synch. Pulse output, 1 min                        | Yes/No               | Insert    |            |
| 2.4   | Fast Ethernet port / FO                           |                      | Yes       |            |
| 2.5   | Serial port                                       |                      | Yes       |            |
| 2.6   | Protocol                                          |                      | NTP       |            |
|       | Overall compliance with the requirements (yes/no) |                      |           |            |

## 7.21 Weather Station (Optional)

| No. | Description                         | Minimum Requirements |        | Guaranteed |
|-----|-------------------------------------|----------------------|--------|------------|
|     |                                     | Unit                 | Data   |            |
|     | Weather Station                     |                      |        |            |
| 1.1 | Terminal Type                       |                      | Insert |            |
| 1.2 | Terminal version (software version) |                      | Insert |            |

| No.     | Description                                                    | Minimum Requirements |                            | Guaranteed |
|---------|----------------------------------------------------------------|----------------------|----------------------------|------------|
|         |                                                                | Unit                 | Data                       |            |
| 1.3     | Standards                                                      |                      | IEC                        |            |
| 2       | Characteristics                                                |                      |                            |            |
| 2.1     | Hygro-thermo transmitter with weather thermal radiation shield |                      |                            |            |
| 2.1.1   | Input                                                          | °C                   | –40..+60                   |            |
| 2.1.1.1 | Output                                                         | mA                   | 4-20                       |            |
| 2.1.1.2 | Accuracy                                                       |                      | 1/3 Class B ( $\pm 0.3$ K) |            |
| 2.1.2   | Input                                                          | % rel. h             | 0..100                     |            |
| 2.1.2.1 | Output                                                         | mA                   | 4-20                       |            |
| 2.1.2.2 | Accuracy                                                       | % rel. h             | $\pm 3$                    |            |
| 2.2     | Wind transmitter                                               | Yes/No               |                            |            |
| 2.2.1   | Input                                                          | m/s                  |                            |            |
| 2.2.2   | Output                                                         | mA                   |                            |            |
| 2.2.3   | Accuracy                                                       | %                    |                            |            |
| 2.3     | Wind direction transmitter                                     | Yes/No               |                            |            |
| 2.3.1   | Input                                                          | °                    |                            |            |
| 2.3.2   | Output                                                         | mA                   |                            |            |
| 2.3.3   | Accuracy                                                       | °                    |                            |            |
| 2.4     | Baro transmitter                                               | Yes/No               |                            |            |
| 2.4.1   | Input                                                          | mbar                 |                            |            |
| 2.4.2   | Output                                                         | mA                   |                            |            |
| 2.5     | Interface unit                                                 |                      | Yes                        |            |
| 2.6     | Overvoltage protection                                         |                      | Yes                        |            |
| 2.7     | Installation                                                   |                      | Indoor                     |            |
|         | Overall compliance with the requirements (yes/no)              |                      |                            |            |

## 7.22 Ethernet Switch Process LAN

| No.   | Description                                      | Minimum Requirements |        | Guaranteed |
|-------|--------------------------------------------------|----------------------|--------|------------|
|       |                                                  | Unit                 | Data   |            |
| 14273 | Ethernet Switch-Process LAN / Code number: 14273 |                      |        |            |
| 1.1   | Terminal Type                                    |                      | Insert |            |
| 1.2   | Terminal version (software version)              |                      | Insert |            |
| 1.3   | Standards                                        |                      | IEC    |            |
| 2     | Characteristics                                  |                      |        |            |
| 2.1   | Auxiliary supply voltage                         |                      |        |            |

| No.    | Description                                                    | Minimum Requirements |                                                                                                                               | Guaranteed |
|--------|----------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------|------------|
|        |                                                                | Unit                 | Data                                                                                                                          |            |
| 2.1.1  | Rated auxiliary supply voltage                                 | V d.c.               | 110 ±15 %                                                                                                                     |            |
| 2.1.2  | Dual power supply                                              |                      | Yes                                                                                                                           |            |
| 2.2    | Ethernet ports                                                 |                      |                                                                                                                               |            |
| 2.2.1  | Number of ports                                                |                      | Min. 6xRJ45 or<br>Min. 6xFO for IED<br>connections AND<br>2xFO (1 GB) for<br>process LAN                                      |            |
| 2.2.1  | Type of ports                                                  |                      | RJ45 or FO and<br>Fibre Optical (1 GB)                                                                                        |            |
| 2.3    | Immunity to EMI and heavy electrical<br>surges                 |                      | Insert                                                                                                                        |            |
| 2.4    | Temperature range                                              |                      |                                                                                                                               |            |
| 2.4.1  | Operation                                                      |                      | 0..50°C                                                                                                                       |            |
| 2.4.2  | Storage                                                        |                      | -20..+70°C                                                                                                                    |            |
| 2.5    | Switching method an layer                                      |                      | Store & Forward<br>Layer 3 (IEC<br>61850), RSTP<br>(802.1w);<br>eRSTPTM or RSTP<br>(802.1D-2004)<br>network fault<br>recovery |            |
| 2.6    | Switching latency                                              |                      | ≤ 5μs                                                                                                                         |            |
| 2.7    | Switching bandwidth                                            |                      | ≤ 1.6 Gbps                                                                                                                    |            |
| 2.8    | Failsafe output relay                                          |                      | Potential-free                                                                                                                |            |
| 2.9    | Cyber security features                                        |                      |                                                                                                                               |            |
| 2.9.1  | Multi-level passwords                                          |                      | Yes                                                                                                                           |            |
| 2.9.2  | SSH/SSL encryption                                             |                      | Yes                                                                                                                           |            |
| 2.9.3  | Enable/disable ports, MAC based port<br>security               |                      | Yes                                                                                                                           |            |
| 2.9.4  | Port based network access control                              |                      | Yes                                                                                                                           |            |
| 2.10   | System features                                                |                      |                                                                                                                               |            |
| 2.10.1 | Automatic learning negotiation and<br>crossover detection      |                      |                                                                                                                               |            |
| 2.10.2 | Port configuration, status, statistics,<br>mirroring, security |                      |                                                                                                                               |            |
| 2.10.3 | Network fault recovery                                         |                      | ≤ 5 ms                                                                                                                        |            |
| 2.11   | Type Test Reports                                              |                      | To be included with<br>bid                                                                                                    |            |
| 2.12   | Installation                                                   |                      | Indoor                                                                                                                        |            |

| No. | Description                                       | Minimum Requirements |      | Guaranteed |
|-----|---------------------------------------------------|----------------------|------|------------|
|     |                                                   | Unit                 | Data |            |
|     | Overall compliance with the requirements (yes/no) |                      |      |            |

Technical characteristics of optical ports of process LAN Ethernet switches must comply with appropriate characteristics of fibre optic cables for protection and control (see Code No. 14296).

### 7.23 Ethernet Switch Control Room

| No.   | Description                                       | Minimum Requirements |                                                                                                          | Guaranteed |
|-------|---------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------|------------|
|       |                                                   | Unit                 | Data                                                                                                     |            |
| 14274 | Ethernet Switch-Control Room / Code number: 14274 |                      |                                                                                                          |            |
| 1.1   | Terminal Type                                     |                      | Insert                                                                                                   |            |
| 1.2   | Terminal version (software version)               |                      | Insert                                                                                                   |            |
| 1.3   | Standards                                         |                      | IEC                                                                                                      |            |
| 2     | Characteristics                                   |                      |                                                                                                          |            |
| 2.1   | Auxiliary supply voltage                          |                      |                                                                                                          |            |
| 2.1.1 | Rated auxiliary supply voltage                    | V d.c.               | 110 ±15 %                                                                                                |            |
| 2.1.2 | Dual power supply                                 |                      | Yes                                                                                                      |            |
| 2.2   | Ethernet ports                                    |                      |                                                                                                          |            |
| 2.2.1 | Number of ports                                   |                      | Min. 16                                                                                                  |            |
| 2.2.1 | Type of ports                                     |                      | RJ45                                                                                                     |            |
| 2.3   | Immunity to EMI and heavy electrical surges       |                      | Insert                                                                                                   |            |
| 2.4   | Temperature range                                 |                      |                                                                                                          |            |
| 2.4.1 | Operation                                         |                      | 0..50°C                                                                                                  |            |
| 2.4.2 | Storage                                           |                      | −20..+70°C                                                                                               |            |
| 2.5   | Switching method an layer                         |                      | Store & Forward Layer 3 (IEC 61850), RSTP (802.1w); eRSTPTM or RSTP (802.1D-2004) network fault recovery |            |
| 2.6   | Switching latency                                 |                      | ≤ 5μs                                                                                                    |            |
| 2.7   | Switching bandwidth                               |                      | ≤ 1.6 Gbps                                                                                               |            |
| 2.8   | Failsafe output relay                             |                      | Potential-free                                                                                           |            |
| 2.9   | Cyber security features                           |                      |                                                                                                          |            |

| No.    | Description                                                 | Minimum Requirements |                         | Guaranteed |
|--------|-------------------------------------------------------------|----------------------|-------------------------|------------|
|        |                                                             | Unit                 | Data                    |            |
| 2.9.1  | Multi-level passwords                                       |                      | Yes                     |            |
| 2.9.2  | SSH/SSL encryption                                          |                      | Yes                     |            |
| 2.9.3  | Enable/disable ports, MAC based port security               |                      | Yes                     |            |
| 2.9.4  | Port based network access control                           |                      | Yes                     |            |
| 2.10   | System features                                             |                      |                         |            |
| 2.10.1 | Automatic learning negotiation and crossover detection      |                      |                         |            |
| 2.10.2 | Port configuration, status, statistics, mirroring, security |                      |                         |            |
| 2.10.3 | Network fault recovery                                      |                      | ≤ 5 ms                  |            |
| 2.11   | Type Test Reports                                           |                      | To be included with bid |            |
| 2.12   | Installation                                                |                      | Indoor                  |            |
|        | Overall compliance with the requirements (yes/no)           |                      |                         |            |

#### 7.24 Protection Monitoring Software

| No.   | Description                                         | Minimum Requirements |        | Guaranteed |
|-------|-----------------------------------------------------|----------------------|--------|------------|
|       |                                                     | Unit                 | Data   |            |
| 14281 | Protection Monitoring Software / Code number: 14281 |                      |        |            |
| 1.1   | Protection Monitoring Software                      |                      |        |            |
| 1.1.1 | Communication with protection terminals             |                      | Yes    |            |
| 1.1.2 | Protection terminal configuration                   |                      | Yes    |            |
| 1.1.3 | Protection terminal parameter setting               |                      | Yes    |            |
| 1.1.4 | Disturbance data collecting                         |                      | Yes    |            |
| 1.1.5 | Disturbance data analysing                          |                      | Yes    |            |
| 1.1.6 | Other software:                                     |                      | Insert |            |
|       | Overall compliance with the requirements (yes/no)   |                      |        |            |

#### 7.25 SCADA Software

| No. | Description | Minimum Requirements |      | Guaranteed |
|-----|-------------|----------------------|------|------------|
|     |             | Unit                 | Data |            |

|       |                                                         |      |             |  |
|-------|---------------------------------------------------------|------|-------------|--|
| 14282 | SCADA Software / Code number: 14282                     |      |             |  |
| 1.1   | Basic SCADA server software                             |      |             |  |
| 1.1   | Basic SCADA server software                             | pcs. | 2           |  |
| 1.1.1 | Communication with 2 higher level control centres       |      | Yes         |  |
| 1.1.2 | Real-time database management                           |      | Yes         |  |
| 1.1.3 | Data processing                                         |      | Yes         |  |
| 1.1.4 | Data acquisition                                        |      | Yes         |  |
| 1.1.5 | Alarm and event processing                              |      | Yes         |  |
| 1.1.6 | Data archiving                                          |      | Yes         |  |
| 1.1.7 | Report generation and printing                          |      | Yes         |  |
| 1.1.8 | Redundancy management                                   |      | Yes         |  |
| 1.2   | Operator workstation software                           | pcs. | 2           |  |
| 1.3   | Communication software                                  | pcs. | 2           |  |
| 1.3.1 | Communication with 2 higher level control centres       |      | Yes         |  |
| 1.4   | Application libraries                                   | pcs. | 1, optional |  |
| 1.5   | Software tools                                          | pcs. | 1           |  |
| 1.5.1 | Database creating, maintaining and viewing              |      | Yes         |  |
| 1.5.2 | User interface definition                               |      | Yes         |  |
| 1.5.3 | Report definition                                       |      | Yes         |  |
| 1.5.4 | System configuration                                    |      | Yes         |  |
| 1.5.5 | Historical data maintaining                             |      | Yes         |  |
| 1.5.6 | Database and historical data export/import              |      | Yes         |  |
| 1.5.7 | Analysis and diagnostic tools                           |      | Yes         |  |
| 1.5.8 | Training simulator                                      |      | Yes         |  |
| 1.5.9 | Other software tools according to Contractor's concept: |      | Insert      |  |
|       | Overall compliance with the requirements (yes/no)       |      |             |  |

## 7.26 Fibre Optic Cables &amp; Terminal Equipment

| No.   | Description                                                                                                                                                                                                                                                                                | Minimum Requirements |           | Guaranteed |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------|------------|
|       |                                                                                                                                                                                                                                                                                            | Unit                 | Data      |            |
|       | Fibre Optic Cables & Terminal Equipment                                                                                                                                                                                                                                                    |                      |           |            |
| 1.1   | Sufficient quantity of adequate glass fibre optic cables for overall Protection & Control & Monitoring & Metering system should be foreseen and included in the bid.                                                                                                                       |                      | Yes       |            |
| 1.2   | Below proposed quantities shall be verified according to specific Bidder's design.                                                                                                                                                                                                         |                      | Yes       |            |
| 1.3   | Final quantities must be estimated and delivered as per Single Line Diagram and Substation layouts.                                                                                                                                                                                        |                      | Yes       |            |
| 1.4   | At least 20% spare in cable length, as well as in number of fibres in cable, should be foreseen.                                                                                                                                                                                           |                      | Yes       |            |
| 1.5   | Fibre optic ducted cables shall be foreseen.                                                                                                                                                                                                                                               |                      | Yes       |            |
| 1.6   | Type of fibre optic                                                                                                                                                                                                                                                                        |                      | Multimode |            |
| 1.7   | Number of fibres in cable                                                                                                                                                                                                                                                                  |                      | Min. 4    |            |
| 1.8   | Operational Wave length                                                                                                                                                                                                                                                                    |                      | Insert    |            |
| 1.9   | Attenuation factor maximum                                                                                                                                                                                                                                                                 |                      | Insert    |            |
| 1.10  | Band-width minimum                                                                                                                                                                                                                                                                         |                      | Insert    |            |
| 1.11  | Manufacturer                                                                                                                                                                                                                                                                               |                      | Insert    |            |
| 2     | Characteristics                                                                                                                                                                                                                                                                            |                      |           |            |
| 2.1   | Fibre optic terminations.<br>Overall quantities of specific fibre optic terminations should be closely related to number of fibres in each cable (each fibre, used or spare, should be properly terminated).<br>At least 20% spare terminations for each proposed type should be foreseen. |                      | Yes       |            |
| 2.1.1 | Plug connectors type                                                                                                                                                                                                                                                                       |                      | Insert    |            |
| 2.1.2 | Connection technology                                                                                                                                                                                                                                                                      |                      | Insert    |            |
| 2.1.3 | Plug pin type                                                                                                                                                                                                                                                                              |                      | Insert    |            |
| 2.1.4 | Manufacturer                                                                                                                                                                                                                                                                               |                      | Insert    |            |

| No.   | Description                                                                                                                                                                                                                                                                                                       | Minimum Requirements |                                    | Guaranteed |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------|------------|
|       |                                                                                                                                                                                                                                                                                                                   | Unit                 | Data                               |            |
| 2.2   | Optical distributor with connectors<br>Overall quantity of Optical Distributor with Connectors should be closely related to number of relay houses.<br>Optical Distributor with Connectors should be foreseen for both cable ends.<br>At least 10% spare Optical Distributors with Connectors should be foreseen. |                      | Yes                                |            |
| 2.2.1 | Fibre optic cable gland                                                                                                                                                                                                                                                                                           |                      | To accept metal-free optical cable |            |
| 2.2.3 | Patch-cord connection                                                                                                                                                                                                                                                                                             |                      | Yes                                |            |
| 2.2.4 | Type of optical connectors                                                                                                                                                                                                                                                                                        |                      | Insert                             |            |
| 2.2.5 | Manufacturer                                                                                                                                                                                                                                                                                                      |                      | Insert                             |            |
| 2.3   | Patch-cord with optical connectors<br>Overall quantity of fibre optic patch-cord cables should be closely related to number of protection and control devices (terminals) in each particular relay house.<br>At least 20% spare patch-cord cables should be foreseen.                                             |                      | Yes                                |            |
|       | Overall compliance with the requirements (yes/no)                                                                                                                                                                                                                                                                 |                      |                                    |            |

The quantities and specifications of the optical distributor with connectors and patch-cord with optical connectors predicted according to the optical ring configuration for control and according to the configuration of busbar protection.

The technical characteristics of fibre optic cables for protection and control have influence on optical ports characteristics of process LAN Ethernet switches.

**7.27 Special Control Equipment and Tools**

| No.   | Description                                                                                                           | Minimum Requirements |      | Guaranteed |
|-------|-----------------------------------------------------------------------------------------------------------------------|----------------------|------|------------|
|       |                                                                                                                       | Unit                 | Data |            |
|       | Special Control Equipment and Tools                                                                                   |                      |      |            |
| 1.1   | Special Control Equipment and Tools                                                                                   |                      |      |            |
| 1.1.1 | Special equipment and tools for setting, repairing, handling and maintaining of control system                        | set                  | 1    |            |
| 1.1.2 | Software needed for configuration, setting, commissioning, testing, communication, interfacing with substation system | set                  | 1    |            |
| 1.1.3 | Laptop brand-name computer                                                                                            | pcs.                 | 2    |            |
| 1.1.4 | Test plugs, including all necessary accessories (transport case, cables, plugs, etc.)                                 | set                  | 2    |            |
|       | Overall compliance with the requirements (yes/no)                                                                     |                      |      |            |

**7.28 Automatic Voltage Regulation**

| No.   | Description                                                                  | Minimum Requirements |                                                                            | Guaranteed |
|-------|------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------|------------|
|       |                                                                              | Unit                 | Data                                                                       |            |
| 14008 | Automatic Voltage Regulation                                                 |                      |                                                                            |            |
| 1.1   | Manufacturer                                                                 |                      | MR Germany or ABB Sweden make or equivalent.                               |            |
| 1.2   | Country of origin                                                            |                      | Germany / Sweden or from other eligible countries with equivalent quality. |            |
| 1.3   | Terminal type                                                                |                      | Insert                                                                     |            |
| 1.4   | Terminal version (software version)                                          |                      | Insert                                                                     |            |
| 1.5   | Standards                                                                    |                      | IEC                                                                        |            |
| 2     | Characteristics                                                              |                      |                                                                            |            |
| 2.1   | Auxiliary supply voltage                                                     |                      |                                                                            |            |
| 2.1.1 | Rated auxiliary supply voltage                                               | V d.c.               | 110 ±15 %                                                                  |            |
| 2.1.2 | Interruption in auxiliary d.c. voltage:<br>Without resetting<br>Restart time | ms<br>s              | > 50<br>Insert                                                             |            |
| 2.2   | a.c. current inputs                                                          |                      |                                                                            |            |
| 2.2.1 | Number of inputs                                                             |                      | 1                                                                          |            |
| 2.2.2 | Rated current for 110 kV                                                     | A                    | 1                                                                          |            |
| 2.2.3 | Permissive overload, continuous                                              |                      | 3xIr                                                                       |            |
| 2.2.4 | Permissive overload, 1 s                                                     |                      | 100xIr                                                                     |            |
| 2.2.5 | Burden at Ir                                                                 | VA                   | < 0.5                                                                      |            |
| 2.3   | a.c. voltage inputs                                                          |                      |                                                                            |            |
| 2.3.1 | Number of inputs                                                             |                      | Min 4                                                                      |            |
| 2.3.2 | Rated voltage Ph-Ph Ur                                                       | V                    | 100                                                                        |            |
| 2.3.3 | Permissive overload, continuous                                              | % Ur                 | 150                                                                        |            |
| 2.3.4 | Permissive overload, 1 s                                                     | % Ur                 | 250                                                                        |            |
| 2.3.5 | Burden at Ur                                                                 | VA                   | < 0.3                                                                      |            |
| 2.4   | Voltage control function                                                     |                      |                                                                            |            |
| 2.4.1 | Set voltage range                                                            | % Ur2                | Insert                                                                     |            |
| 2.4.2 | Set voltage dead-band range                                                  | % Ur2                | Insert                                                                     |            |
| 2.4.3 | Upper limit busbar voltage range                                             | % Ur2                | Insert                                                                     |            |
| 2.4.4 | Lower limit busbar voltage range                                             | % Ur2                | Insert                                                                     |            |

| No.     | Description                                                                   | Minimum Requirements |            | Guaranteed |
|---------|-------------------------------------------------------------------------------|----------------------|------------|------------|
|         |                                                                               | Unit                 | Data       |            |
| 2.4.5   | Line voltage drop compensation                                                | Yes/No               | Insert     |            |
| 2.4.6   | Regulation for capacitive load                                                | Yes/No               | Insert     |            |
| 2.4.7   | Undervoltage blocking range                                                   | % Ur2                | Insert     |            |
| 2.4.8   | Overcurrent blocking range                                                    | % Ir                 | Insert     |            |
| 2.4.9   | Parallel operation                                                            |                      | Yes        |            |
| 2.4.10  | Parallel operation principal                                                  |                      | Insert     |            |
| 2.5     | Communication ports                                                           |                      | Yes        |            |
| 2.5.1   | Port for front-connected PC                                                   |                      |            |            |
| 2.5.1.1 | Protocols supported                                                           |                      | Insert     |            |
| 2.5.1.2 | Communication speed                                                           | Kbit/s               | Insert     |            |
| 2.5.1.3 | PC side connector type                                                        |                      | Insert     |            |
| 2.5.2   | System interface                                                              |                      |            |            |
| 2.5.2.1 | Number of rear ports                                                          |                      | Min. 1     |            |
| 2.5.2.2 | Protocols supported                                                           |                      | IEC 61850  |            |
| 2.5.2.3 | Communication speed                                                           | Mbit/s               | Min. 100   |            |
| 2.5.2.4 | Connector type                                                                |                      | RJ45 or FO |            |
| 2.5.3   | External time synchronisation                                                 |                      | Insert     |            |
| 2.6     | Tap changer, tap position                                                     |                      | BCD code   |            |
| 2.7     | Self-supervision                                                              |                      | Yes        |            |
| 3       | Additional requirements                                                       |                      |            |            |
| 3.1     | Test socket                                                                   |                      | Yes        |            |
| 3.2     | Setting and configuration of Automatic Voltage Regulator approved by Engineer |                      | Yes        |            |
|         | Overall compliance with the requirements (yes/no)                             |                      |            |            |

**7.29 Test Socket**

| No. | Description                                                                                                                                                                                                                                                                                                                                                        | Minimum Requirements |        | Guaranteed |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------|------------|
|     |                                                                                                                                                                                                                                                                                                                                                                    | Unit                 | Data   |            |
| 1   | Test socket                                                                                                                                                                                                                                                                                                                                                        |                      |        |            |
| 1.1 | Manufacturer                                                                                                                                                                                                                                                                                                                                                       |                      | Insert |            |
| 1.2 | Country of origin                                                                                                                                                                                                                                                                                                                                                  |                      | Insert |            |
| 1.3 | Type<br>Line main 1 and 2<br>Line back-up and bus coupler<br>Transformer main 1 and 2<br>Bay unit BBF<br>Distance protection (code 14007)                                                                                                                                                                                                                          |                      | Insert |            |
| 1.4 | Standards                                                                                                                                                                                                                                                                                                                                                          |                      | IEC    |            |
| 1.5 | Each protection device must have its own test socket                                                                                                                                                                                                                                                                                                               |                      | Yes    |            |
| 1.6 | Test socket must obtain safe online protection testing and maintaining, and performing whole tripping test with following AR                                                                                                                                                                                                                                       |                      | Yes    |            |
| 1.7 | Test socket should have enough contacts to:<br>Short-circuit current inputs from CT's<br>Isolate voltage inputs from VT's<br>Isolate trip circuit for each phase separately<br>Isolate CB close command<br>Isolate signalling voltage<br>Inhibit breaker failure initialising<br>Inhibit sending of communication signal<br>Allow functional testing of protection |                      | Yes    |            |
| 1.8 | Socket should be designed for 4 mm banana plugs access                                                                                                                                                                                                                                                                                                             |                      | Yes    |            |
|     | Overall compliance with the requirements (yes/no)                                                                                                                                                                                                                                                                                                                  |                      |        |            |

**PART 8– SHUNT REACTOR (N/A)**

| SL  | Description                                                                                                                                                                                                                                                                                                                               | Unit                         | Minimum Requirements       | Guaranteed |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------|------------|
| 1.  | Name of manufacturer                                                                                                                                                                                                                                                                                                                      |                              |                            |            |
| 2.  | Model                                                                                                                                                                                                                                                                                                                                     |                              |                            |            |
| 3.  | Country of origin                                                                                                                                                                                                                                                                                                                         |                              |                            |            |
| 4.  | Service conditions:<br><ul style="list-style-type: none"> <li>- External cooling medium</li> <li>- Altitude not exceeding</li> <li>- Air temperature not exceeding</li> </ul> Average air temperature in any one year not exceeding:<br><ul style="list-style-type: none"> <li>- In any one day</li> <li>- Average in one year</li> </ul> | -<br>m<br>°C<br><br>°C<br>°C | As per volume 2 section 1  |            |
| 5.  | Rated voltage                                                                                                                                                                                                                                                                                                                             | kV                           | 420                        |            |
| 6.  | Rated lightning impulse withstand voltage<br><ul style="list-style-type: none"> <li>- HV</li> <li>- Neutral</li> </ul>                                                                                                                                                                                                                    | kV                           | 1425<br><br>insert         |            |
| 7.  | Rated switching impulse withstand voltage<br><ul style="list-style-type: none"> <li>- HV</li> <li>- Neutral</li> </ul>                                                                                                                                                                                                                    | kV                           | 1050<br>NA                 |            |
| 8.  | Rated power Frequency withstand voltage<br><ul style="list-style-type: none"> <li>- HV</li> <li>- Neutral</li> </ul>                                                                                                                                                                                                                      | kV                           | 650<br><br>insert          |            |
| 9.  | Rated Capacity                                                                                                                                                                                                                                                                                                                            |                              | 25 MVar                    |            |
| 10. | Vector Group                                                                                                                                                                                                                                                                                                                              |                              | Grounded Wye               |            |
| 11. | Method of Earthing                                                                                                                                                                                                                                                                                                                        |                              | Solidly Earth              |            |
| 12. | Maximum temperature Rise<br><ul style="list-style-type: none"> <li>- windings</li> <li>- Top oil</li> <li>- Hot spot of Core</li> </ul>                                                                                                                                                                                                   | °C                           | Insert<br>Insert<br>insert |            |
| 13. | Total Losses at rated voltage & frequency<br><ul style="list-style-type: none"> <li>- Core Loss</li> <li>- Copper Loss</li> <li>- Total</li> </ul>                                                                                                                                                                                        | kW                           | Insert<br>Insert<br>insert |            |
| 14. | Cooling                                                                                                                                                                                                                                                                                                                                   |                              | ONAN                       |            |
| 15. | Rated Power at Rated voltage & frequency                                                                                                                                                                                                                                                                                                  | MVar                         | 25MVar                     |            |
| 16. | Rated Current                                                                                                                                                                                                                                                                                                                             | A                            | insert                     |            |
| 17. | Rated reactance/phase                                                                                                                                                                                                                                                                                                                     | Ω                            | insert                     |            |
| 18. | Zero sequence reactance                                                                                                                                                                                                                                                                                                                   | Ω                            | insert                     |            |
| 19. | Mutual Reactance                                                                                                                                                                                                                                                                                                                          | Ω                            | insert                     |            |
| 20. | Linearity Range of magnetic circuit percent to rated voltage                                                                                                                                                                                                                                                                              | %                            | insert                     |            |
| 21. | Reactance during saturation percent to rated reactance                                                                                                                                                                                                                                                                                    | %                            | insert                     |            |
| 22. | Harmonics<br><ul style="list-style-type: none"> <li>- Even</li> <li>- Total</li> </ul>                                                                                                                                                                                                                                                    | %                            | insert                     |            |
| 23. | Core Design                                                                                                                                                                                                                                                                                                                               | Gapped/Air Core              | insert                     |            |
| 24. | No. of Core                                                                                                                                                                                                                                                                                                                               | No's                         | insert                     |            |

| SL  | Description                                                            | Unit           | Minimum Requirements                                                   | Guaranteed |
|-----|------------------------------------------------------------------------|----------------|------------------------------------------------------------------------|------------|
| 25. | Material & type of Core                                                |                | insert                                                                 |            |
| 26. | Type of winding                                                        |                | insert                                                                 |            |
| 27. | Winding Connection brazed or crimped                                   |                | insert                                                                 |            |
| 28. | Type of Insulation<br>- HV side<br>- Neutral side                      | Non/Uniform    | insert                                                                 |            |
| 29. | Flux Density at Rated voltage & frequency<br>- Core<br>- Yokes         |                | insert                                                                 |            |
| 30. | Volts per turn                                                         |                | insert                                                                 |            |
| 31. | Efficiency                                                             | %              | insert                                                                 |            |
| 32. | Regulation<br>- At unity power factor<br>- At 0.8 lagging power factor | %              | insert                                                                 |            |
| 33. | Bushing Current Transformer<br>-Ratio<br>-Class<br>-Burden             | --<br>--<br>VA | 520<br>30(actual value shall be as per calculation at execution stage) |            |
| 34. | Maximum Sound Pressure level                                           | dB             | 78                                                                     |            |
| 35. | Oil Type                                                               |                | insert                                                                 |            |
| 36. | Weight of Active part                                                  | kg             | insert                                                                 |            |
| 37. | Weight of Oil*                                                         | kg             | insert                                                                 |            |
| 38. | Total weight*                                                          | kg             | insert                                                                 |            |
| 39. | Heaviest part for shipment                                             | kg             | insert                                                                 |            |

\*These values are required for Foundation design & shipping purpose only. During detail design, these values may vary from Bid value due to attaining desired electrical output.

### PART 9 - FIBRE OPTIC MULTIPLEXER EQUIPMENT

Bidder shall provide all necessary information which deem to be necessary to complete the project in all respects.

| No.        | Description                      | Minimum Requirements                        | Guaranteed                     |
|------------|----------------------------------|---------------------------------------------|--------------------------------|
| <b>1.0</b> | <b>GENERAL:</b>                  |                                             |                                |
| 1.1        | Type of multiplexer              | SDH / MPLS-TP / Hybrid (SDH, MPLS-TP) & PDH |                                |
| 1.2        | Complying to ITU-T rec.          | Yes                                         |                                |
| 1.3        | Transmission Capacity            | Mbit/s                                      | STM-4 & STM-16, 1Gbps & 10Gbps |
| 1.4        | Access capacity on 64 kbit/s     | channels                                    | Minimum 200                    |
| 1.5        | Access capacity on 2 Mbit/s      | channels                                    | Minimum 40                     |
| 1.6        | Redundant central processor      |                                             | Shall be available             |
| 1.7        | Digital cross connect function   |                                             | Fully non-blocking             |
| <b>2.0</b> | <b>Available AGGREGATES:</b>     |                                             |                                |
| 2.1        | Optical aggregates (ITU-T G.957) |                                             | As per field requirement       |
| 2.2        | Ethernet (ITU-T G.8112/Y.1371)   |                                             | As per field requirement       |

| No.          | Description                                                                                             | Minimum Requirements               |                                                                  | Guaranteed |
|--------------|---------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------------------------------------|------------|
| <b>1.0</b>   | <b>GENERAL:</b>                                                                                         |                                    |                                                                  |            |
| <b>3.0</b>   | <b>Available TRUNK INTERFACES:</b>                                                                      |                                    |                                                                  |            |
| 3.1          | HDB3, 2 Mbit/s interfaces per module                                                                    | Nos.                               | Minimum 8                                                        |            |
| 3.2          | Complying to ITU-T rec.                                                                                 |                                    | G.703, transparent<br>G.704, selectable<br><b>G.8112/Y.1371</b>  |            |
| 3.3          | HDSL, 2Mbit/s interface: no of copper wires<br>Capacity on 2Mbit/s or on 1Mbit/s<br>Capacity selectable | Nos.<br>ch<br>ch / pair<br>of wire | 4 or 2<br>30 or 15<br>30 / 2 pairs<br>30 / 1 pair<br>15 / 1 pair |            |
| <b>4.0</b>   | <b>Available USER INTERFACES</b>                                                                        |                                    |                                                                  |            |
| <b>4.1</b>   | <b>Voice interfaces for trunk lines:</b>                                                                |                                    |                                                                  |            |
| 4.1.1        | 1 + 1 com path protection, available for all                                                            |                                    | Yes                                                              |            |
| 4.1.2        | Analogue, 2wire with E&M: Input level<br><br>Output level                                               | dBr                                | +6.5 .. -12.5<br>-1.0 .. -20                                     |            |
| 4.1.3        | Digital, 2Mbit/s CAS or PRI                                                                             |                                    | Yes                                                              |            |
| <b>4.2</b>   | <b>Voice interfaces for remote subscriber:</b>                                                          |                                    |                                                                  |            |
| 4.2.1        | 2wire, subscriber side                                                                                  | dBr                                | -5 .. +4 / -7.5 .. -1                                            |            |
| 4.2.2        | 2wire, PABX side                                                                                        | dBr                                | -5 .. +4 / -7.5 .. -3                                            |            |
| <b>4.3</b>   | <b>Integrated teleprotection</b>                                                                        |                                    |                                                                  |            |
| <b>4.3.1</b> | <b>Interface for Commands:</b>                                                                          |                                    |                                                                  |            |
| 4.3.1.1      | Number of independent commands                                                                          | Nos.                               | 4                                                                |            |
| 4.3.1.2      | Transmission time max.                                                                                  | ms                                 | 6                                                                |            |
| 4.3.1.3      | Signal voltage                                                                                          | V <sub>peak</sub>                  | 250                                                              |            |
| 4.3.1.4      | 1 + 1 com path protection                                                                               |                                    | Yes                                                              |            |
| <b>4.3.2</b> | <b>Interface(s) for Differential Protection:</b>                                                        |                                    |                                                                  |            |
| 4.3.2.1      | Electrical interface: G.703                                                                             | kbit/s                             | 64                                                               |            |
| 4.3.2.2      | Optical Interface : <b>IEEE C37.94</b>                                                                  | kbit/s                             | Minimum 64                                                       |            |
| <b>4.4</b>   | <b>Data: channels per module</b>                                                                        |                                    |                                                                  |            |
| 4.4.1        | 1 + 1 com path protection, available for all                                                            |                                    | Yes                                                              |            |
| 4.4.2        | <del>V.24/V.28 (RS-232) data interface</del>                                                            | <del>Nos.</del>                    | <del>4</del>                                                     |            |
| 4.4.3        | <del>V.11/X.24 (RS-422) data interface</del>                                                            | <del>Nos.</del>                    | <del>4</del>                                                     |            |
| 4.4.4        | <del>V.35/V.36 (RS-485) data interface</del>                                                            |                                    | <del>4</del>                                                     |            |
| 4.4.5        | G.703: 64kbit/s                                                                                         | Nos.                               | 8                                                                |            |

| No.        | Description                                         | Minimum Requirements |                                    | Guaranteed |
|------------|-----------------------------------------------------|----------------------|------------------------------------|------------|
| <b>1.0</b> | <b>GENERAL:</b>                                     |                      |                                    |            |
| 4.4.6      | Ethernet: 10/100 BaseT<br>WAN capacity<br>Protocols | Nos.<br>Mbit/s       | 1<br>Min: 2x 2Mbit/s<br>Min.: IP   |            |
| <b>4.5</b> | <b>Integrated alarm gathering module:</b>           |                      |                                    |            |
| 4.5.1      | Number of external alarms per module                | Nos.                 | Min. 20                            |            |
| 4.5.2      | Auxiliary power supply for ext. contacts            |                      | Yes                                |            |
| <b>4.6</b> | <b>Network Management System</b>                    |                      |                                    |            |
| 4.6.1      | Type/Name of configuration tool                     |                      |                                    |            |
| 4.6.2      | For fault / configuration management                |                      | Yes / yes                          |            |
| 4.6.3      | For local / remote operation                        |                      | Yes / yes                          |            |
| 4.6.4      | Data communication network (DCN)                    |                      | Ethernet / IP or<br>Ethernet / OSI |            |
| <b>4.7</b> | <b>Ambient Conditions:</b>                          |                      |                                    |            |
| 4.7.1      | Storage: ETS 300 019-1-1, class 1.2                 | °C / %<br>hum        | -25 .. + 55 / class 1.2            |            |
| 4.7.2      | Transport: ETS 300 019-1-2, class 2.2               | °C / %<br>hum        | -25 .. + 70 / class 2.2            |            |
| 4.7.3      | Operation: ETS 300 019-1-3, class 3.1E              | °C / %<br>hum        | -5 .. +45 / class 3.1E             |            |
| <b>4.8</b> | <b>Power Supply</b>                                 |                      |                                    |            |
| 4.8.1      | Operation                                           | VDC                  | 48 / 60 (-15/+20%)                 |            |
| 4.8.2      | Fully redundant power supply                        |                      | Yes                                |            |

## PART -10

### 10.0 POWER LINE CARRIER EQUIPMENT

|             |                                |                                                                        |            |
|-------------|--------------------------------|------------------------------------------------------------------------|------------|
| <b>10.1</b> | <b>Line Trap</b>               | 400kV                                                                  | Guaranteed |
| 9.          | Manufacturer/model             |                                                                        |            |
| 10.         | Type                           |                                                                        |            |
| 11.         | Rated continuous current       |                                                                        |            |
| 12.         | Type of Line Trap Installation | To be inserted into high voltage A.C transmission line phase in series |            |
| 13.         | Type of mounting               | Pedestal                                                               |            |
| 14.         | Suitable for system Frequency  | --50Hz--                                                               |            |

|     |                                                                                      |                                                                                                                                                   |  |
|-----|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 15. | Nominal System Voltage                                                               | 400 KV                                                                                                                                            |  |
| 16. | Highest System Voltage                                                               | 420 KV                                                                                                                                            |  |
| 17. | Rated Continuous Current                                                             | 4000 A                                                                                                                                            |  |
| 18. | Rated Short time current for 1 second                                                | 63kA                                                                                                                                              |  |
| 19. | Asymmetrical peak value of the First half wave of the rates short Time current       | 158 KA                                                                                                                                            |  |
| 20. | Rated inductance                                                                     | 1.0 mH                                                                                                                                            |  |
| 21. | Type of Tuning                                                                       | Band tuned line trap                                                                                                                              |  |
| 22. | Blocking Band frequency range                                                        | Band-I 56 to 124 KHZ<br>Band- II 76 to 500 KHZ                                                                                                    |  |
| 23. | Minimum Guaranteed resistive Component of impedance in Blocking Frequency Rang       | 500 Ohm                                                                                                                                           |  |
| 24. | Protective device                                                                    | a) Non-linear resistive type Gapped lightning arresters for A.C system.<br>Polymer housed Metal oxide surge arrester without Gaps for A.C system. |  |
| 25. | Nominal discharge current of protective device                                       | 10 KA. However, Co-ordination shall be done by taking 20KA 8/20 micro-sec discharge in to consideration.                                          |  |
| 26. | Rated voltage of protective device                                                   | >15.72 KV rms                                                                                                                                     |  |
| 27. | Minimum value of power frequency spark over voltage (Dry & wet) of protective device | >23.58KV rms                                                                                                                                      |  |
| 28. | Visual Corona Extinction Volt                                                        | 320 KV rms                                                                                                                                        |  |
| 29. | Radio influence Voltage (RIV)                                                        | <500 micro Volt@280 KV                                                                                                                            |  |
| 30. | Attention in tuned frequency band                                                    | <7.5 dB                                                                                                                                           |  |
| 31. | Maximum tapping loss over blocking Band I & II stated above                          | 2.6 dB                                                                                                                                            |  |
| 32. | Insulation class                                                                     | Class F Insulation                                                                                                                                |  |
| 33. | Maximum working stress                                                               | Twice the weight of wave trap+500Kgs.                                                                                                             |  |
| 34. | Coil inductance                                                                      |                                                                                                                                                   |  |
| 35. | Air temperature operating range                                                      |                                                                                                                                                   |  |
| 36. | Weight of trap                                                                       |                                                                                                                                                   |  |
| 37. | Type of protective device                                                            |                                                                                                                                                   |  |
| 38. | Temperature rise at normal rating                                                    |                                                                                                                                                   |  |
| 39. | Dynamic short circuit rating                                                         |                                                                                                                                                   |  |
| 40. | Temperature rise at short circuit rating                                             |                                                                                                                                                   |  |
| 41. | Working tension of strain (mounted units)                                            |                                                                                                                                                   |  |
| 42. | Bandwidth blocked band                                                               |                                                                                                                                                   |  |
| 43. | Minimum impedance in working bandwidth                                               |                                                                                                                                                   |  |
| 44. | Compatibility with IEC Recommendation 353                                            |                                                                                                                                                   |  |
| 45. | Mounting details                                                                     |                                                                                                                                                   |  |
| 46. | MTBF                                                                                 |                                                                                                                                                   |  |
| 47. | Design Life                                                                          |                                                                                                                                                   |  |
| 48. | Equipment technical description                                                      |                                                                                                                                                   |  |

|             |                                                                                                                                             |        |  |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------|--|
| <b>12.2</b> | <b>HF Coupling Unit</b>                                                                                                                     | 400kV  |  |
| 1.          | Manufacturer/model                                                                                                                          |        |  |
| 2.          | Type                                                                                                                                        |        |  |
| 3.          | Working temperature range                                                                                                                   |        |  |
| 4.          | Available bandwidth                                                                                                                         |        |  |
| 5.          | Tuning range                                                                                                                                |        |  |
| 6.          | Composite loss over tuning range                                                                                                            |        |  |
| 7.          | Line side impedance range for phase/phase coupling                                                                                          |        |  |
| 8.          | Equipment side impedance                                                                                                                    |        |  |
| 9.          | Drain coil current carrying <ul style="list-style-type: none"> <li>• continuous</li> <li>• for 1 second</li> <li>• for 3 seconds</li> </ul> |        |  |
| 10.         | Isolation transformer voltage withstand for 1 minute                                                                                        |        |  |
| 11.         | Main arrester voltage                                                                                                                       |        |  |
| 12.         | Earth switch interlock with door                                                                                                            |        |  |
| 13.         | Compatibility with IEC Recommendation 481                                                                                                   |        |  |
| <b>12.3</b> | <b>High Frequency Cable</b>                                                                                                                 | 400 kV |  |
| 1.          | Manufacturer                                                                                                                                |        |  |
| 2.          | Type                                                                                                                                        |        |  |
| 3.          | Coaxial or quad                                                                                                                             |        |  |
| 4.          | Surge impedance                                                                                                                             |        |  |
| 5.          | Voltage withstand: <ul style="list-style-type: none"> <li>• between conductors</li> <li>• between cores and armouring</li> </ul>            |        |  |
|             | Attenuation per km: <ul style="list-style-type: none"> <li>• at 50 kHz</li> <li>• at 400 kHz</li> </ul>                                     |        |  |
| <b>12.4</b> | <b>Digital PLC Terminal</b>                                                                                                                 |        |  |
| 1.          | Manufacturer/model                                                                                                                          |        |  |
| 2.          | Type                                                                                                                                        |        |  |
| 3.          | Compliance with relevant parts of IEC 495                                                                                                   |        |  |
| 4.          | DC voltage working range                                                                                                                    |        |  |

|     |                                                                                                                                                                                                                      |  |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 5.  | Service conditions (temperature and RH)                                                                                                                                                                              |  |
| 6.  | Power consumption                                                                                                                                                                                                    |  |
| 7.  | Design life                                                                                                                                                                                                          |  |
| 8.  | Carrier frequency range                                                                                                                                                                                              |  |
| 9.  | Gross bandwidth                                                                                                                                                                                                      |  |
| 10. | Teleprotection equipment mounted within the PLC units                                                                                                                                                                |  |
| 11. | Technical description of the equipment                                                                                                                                                                               |  |
| 12. | Type of coupling (phase/phase or inter circuit)                                                                                                                                                                      |  |
| 13. | Return loss within the carrier frequency band                                                                                                                                                                        |  |
| 14. | Transmission rate of the digital signal                                                                                                                                                                              |  |
| 15. | Output impedance                                                                                                                                                                                                     |  |
| 16. | Dynamic range of receiver for digital signal                                                                                                                                                                         |  |
| 17. | Means of RF frequency selection                                                                                                                                                                                      |  |
| 18. | frequency spacing for parallel connections <ul style="list-style-type: none"> <li>• between two digital PLCs</li> <li>• between a digital and an analogue PLC</li> </ul>                                             |  |
| 19. | Output power (before hybrid at coaxial cable)                                                                                                                                                                        |  |
| 20. | Channel terminal power at output to coupling equipment                                                                                                                                                               |  |
| 21. | Type of digital modulation available/proposed                                                                                                                                                                        |  |
| 22. | Calculations to justify operation of the PLC over the transmission lines                                                                                                                                             |  |
| 23. | Any limitations in parallelling of terminals (to digital or analogue PLCs)                                                                                                                                           |  |
| 24. | Required minimum SNR for minimum BER                                                                                                                                                                                 |  |
| 25. | Switching off of parallel PLCs, not to cause interference with working PLCs                                                                                                                                          |  |
| 26. | Spurious emissions                                                                                                                                                                                                   |  |
|     | <b>Digital PLC Terminal (Terminal)</b>                                                                                                                                                                               |  |
| 27. | Maximum transmitting level for parasitic signals: <ul style="list-style-type: none"> <li>• 0-4 kHz from the band limits</li> <li>• 4-8 kHz from the band limits</li> <li>• &gt;8 kHz from the band limits</li> </ul> |  |
| 28. | Voltage withstand                                                                                                                                                                                                    |  |
| 29. | Capacity options available for various services                                                                                                                                                                      |  |

|     |                                                              |  |
|-----|--------------------------------------------------------------|--|
|     | equipped within the digital bit stream                       |  |
| 30. | Capacity allocation proposed for this project                |  |
| 31. | Speech channel 2W/4W interface                               |  |
| 32. | Speech channel impedance/levels                              |  |
| 33. | "Long line" telephone facility                               |  |
| 34. | Speech channel interfaces available (E&M etc.)               |  |
| 35. | Service telephone                                            |  |
| 36. | Type of speech codec                                         |  |
| 37. | Compatibility with analogue speech bands                     |  |
| 38. | Method of telephone signalling                               |  |
| 39. | Frequency response of speech channel (Ref 800 Hz)            |  |
| 40. | Data channel interface                                       |  |
| 41. | Synchronous/asynchronous data channel availability           |  |
| 42. | Data signalling transmission rates which can be accommodated |  |
| 43. | FSK Interface                                                |  |
| 44. | VFT signal levels (2W and 4W)                                |  |
| 45. | Frequency response of VFT channel (Ref 3 kHz)                |  |
| 46. | Test facilities                                              |  |
| 47. | Alarm facilities                                             |  |
| 48. | Equipment technical description                              |  |
| 49. | Terminal MTBF                                                |  |
| 50. | Single or duplicated PSU                                     |  |
|     | <b>Teleprotection Equipment</b>                              |  |
| 1.  | Manufacturer/model                                           |  |
| 2.  | Type                                                         |  |
| 3.  | DC voltage working range                                     |  |
| 4.  | Service conditions (temperature and RH)                      |  |
| 5.  | Power consumption                                            |  |
| 6.  | Configured for analogue or digital communications media      |  |
| 7.  | Design life                                                  |  |
|     |                                                              |  |

|             |                                                                                                                                     |  |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------|--|
| 8.          | Suitable for direct, permissive, blocking signalling                                                                                |  |
| 9.          | Single/duplication of teleprotection signals                                                                                        |  |
| 10.         | VFT channel allocation and bandwidth                                                                                                |  |
| 11.         | Frequency or coded signalling                                                                                                       |  |
| 12.         | Use of guard channel                                                                                                                |  |
| 13.         | Signal transmission time                                                                                                            |  |
| 14.         | Modem programmability                                                                                                               |  |
| 15.         | Means of monitoring communications channel                                                                                          |  |
| 16.         | Transmission of "trip/send" signal at increased level                                                                               |  |
| 17.         | No. of signals per terminal                                                                                                         |  |
| 18.         | Facility to hold on output signal                                                                                                   |  |
| 19.         | Trip extension facility/time                                                                                                        |  |
| 20.         | Minimum/maximum input pulse and corresponding output                                                                                |  |
| 21.         | No. of receive output contracts                                                                                                     |  |
| 22.         | Provision of counters                                                                                                               |  |
| 23.         | Voltage withstand                                                                                                                   |  |
| 24.         | Transmitter level output range                                                                                                      |  |
| 25.         | Receiver sensitivity range                                                                                                          |  |
| 26.         | Receiver alarm level or BER referred to nominal                                                                                     |  |
| 27.         | Minimum alarm contact closure time                                                                                                  |  |
| 28.         | No. of alarm contacts                                                                                                               |  |
| 29.         | 19"/ETSI rack mounting practice                                                                                                     |  |
|             | <b>Teleprotection Equipment (Continued)</b>                                                                                         |  |
| 30.         | Information to be submitted with the Tender<br>(a) Technical description<br>(b) MTBF calculations<br>(c) Performance graphs/details |  |
| <b>12.6</b> | <b>PAX Telephone Equipment and Subscriber Equipment</b>                                                                             |  |
| <b>(a)</b>  | <b>Exchange equipment</b>                                                                                                           |  |
| 1.          | Type reference                                                                                                                      |  |
| 2.          | Manufacturer                                                                                                                        |  |
|             |                                                                                                                                     |  |

|            |                                                                                                                                                                                             |  |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 3.         | Dimensions of cubicle                                                                                                                                                                       |  |
| 4.         | Rack width                                                                                                                                                                                  |  |
| 5.         | Literature reference for typical layout of cubicle                                                                                                                                          |  |
| 6.         | Operating temperature range                                                                                                                                                                 |  |
| 7.         | Operating relative humidity                                                                                                                                                                 |  |
| 8.         | Power requirements                                                                                                                                                                          |  |
| 9.         | Mean time between failures                                                                                                                                                                  |  |
| 10.        | Maximum number of local extensions                                                                                                                                                          |  |
| 11.        | Maximum number of remote extensions                                                                                                                                                         |  |
| 12.        | Maximum number of trunk lines                                                                                                                                                               |  |
| 13.        | Maximum number of connecting circuits                                                                                                                                                       |  |
| 14.        | Method of signalling <ul style="list-style-type: none"> <li>• Local extensions</li> <li>• Remote extensions</li> <li>• Trunk lines</li> </ul> 4W                                            |  |
| 15.        | Frequency of audible tones <ul style="list-style-type: none"> <li>• Dial tone</li> <li>• Busy tone</li> <li>• Ringing tone</li> <li>• Ringing current</li> <li>• Ringing current</li> </ul> |  |
| 16.        | Ring voltage                                                                                                                                                                                |  |
| 17.        | Type of processor                                                                                                                                                                           |  |
| 18.        | Type of memory                                                                                                                                                                              |  |
| <b>(b)</b> | <b>Subscriber telephone</b>                                                                                                                                                                 |  |
| 1.         | Type reference                                                                                                                                                                              |  |
| 2.         | Manufacturer                                                                                                                                                                                |  |
| 3.         | Type of dial (rotary/pushbutton)                                                                                                                                                            |  |
| 4.         | Operating voltage                                                                                                                                                                           |  |
| 5.         | Outdoor bell                                                                                                                                                                                |  |
| 6.         | Type reference                                                                                                                                                                              |  |
| 7.         | Manufacturer                                                                                                                                                                                |  |
| 8.         | Operating voltage                                                                                                                                                                           |  |

## POWER GRID BANGLADESH PLC

### BIDDING DOCUMENT FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]  
SCHEDULE F**

### DEPARTURES FROM THE SPECIFICATION

Bidders are to list all departures from the requirements of the specification in this schedule.

All departures whether they be commercial, financial, technical or of a contractual nature are to be included and shall be submitted with the Technical proposal

Any item that does not have a departure listed in this schedule will be deemed to be in full accordance with the requirements of the specification.

No other document or detail accompanying the tender will be considered in evaluating departures. Bidders are not permitted to offer any alternative to this schedule.

| Item | Volume | Clause | Detail of Departure from Specification |
|------|--------|--------|----------------------------------------|
|      |        |        |                                        |

# POWER GRID BANGLADESH PLC

## BIDDING DOCUMENT FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]  
SCHEDULE G**

### PROPOSED ALTERNATIVE STANDARDS TO WHICH EQUIPMENT SHALL BE PROVIDED

The bidder shall list below all the alternative engineering and design Standards, which he proposes to use in his design, manufacture and testing of equipment to be supplied. Should these standards differ from the specified standard in any respect, the bidder shall detail the differences between the proposed and specified standard.

Compliance with any standard equal or superior to those specified will be considered acceptable.

In the absence of any listed alternative standard, it is deemed that the standards specified in the Tender documents are fully complied with.

| Specified Standard | Alternative Standard |       |
|--------------------|----------------------|-------|
|                    | Number               | Title |
|                    |                      |       |

## POWER GRID BANGLADESH PLC

### BIDDING DOCUMENT FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at  
Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey  
basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]  
SCHEDULE H**

### PROPOSED CONTRACT & SITE ORGANISATION

#### Personnel

Bidders should provide the names of suitably qualified personnel to meet the requirements specified in Section 3 (Evaluation and Qualification Criteria) of Volume 1 of 3 of the Bidding Document. The data on their experience should be supplied using the Form below for each candidate.

#### Form PER – 1: Proposed Personnel

|    |                    |
|----|--------------------|
| 1. | Title of position* |
|    | Name               |
| 2. | Title of position* |
|    | Name               |
| 3. | Title of position* |
|    | Name               |
| 4. | Title of position* |
|    | Name               |

\*As listed in Section 3 (Evaluation and Qualification Criteria).

Schedule H: Proposed contract & site organization and site resources

Form PER – 2: Resume of Proposed Personnel

|                       |                             |                                       |
|-----------------------|-----------------------------|---------------------------------------|
| Position              |                             |                                       |
| Personnel information | Name                        | Date of birth                         |
|                       | Professional qualifications |                                       |
| Present employment    | Name of employer            |                                       |
|                       | Address of employer         |                                       |
|                       | Telephone                   | Contact (manager / personnel officer) |
|                       | Fax                         | E-mail                                |
|                       | Job title                   | Years with present employer           |

Summarize professional experience in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

| From | To | Company / Project / Position / Relevant technical and management experience |
|------|----|-----------------------------------------------------------------------------|
|      |    |                                                                             |
|      |    |                                                                             |
|      |    |                                                                             |
|      |    |                                                                             |
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|      |    |                                                                             |
|      |    |                                                                             |
|      |    |                                                                             |

Schedule I: Drawings and Documents

## **POWER GRID BANGLADESH PLC**

### **BIDDING DOCUMENT FOR**

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at  
Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey  
basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]  
SCHEDULE I**

### **DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH TENDER**

DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH TENDER SHALL BE AS PER SECTION 6  
OF VOLUME 1 OF 3.

## POWER GRID BANGLADESH PLC

### BIDDING DOCUMENT FOR

**Design, Supply, Installation, Testing & Commissioning of 400/230/132 kV AIS Substation at  
Pekua and associated single /double circuit 400kV/230kV/132kV LILO Lines on turnkey  
basis(Package-1)**

**[Contract No.: POWERGRID/ADB/400kV/PEKUA/PTSIREP/PACKAGE-1/Re-Tender]  
SCHEDULE J**

### PROPOSED SUBCONTRACTORS

The bidder shall propose a list of the Sub-contractors in the following table as per sub-clause 2.7, Item 2, Civil Subcontractors, Section-3, Evaluation and Qualification Criteria, Volume 1 of 3 of the Bidding Document.

| Sl. No. | Name and Address of the Subcontractor |
|---------|---------------------------------------|
|         |                                       |

Signature \_\_\_\_\_  
Date \_\_\_\_\_