

**STANDARD BIDDING DOCUMENT**

**PROCUREMENT OF PLANT DESIGN,  
SUPPLY, AND INSTALLATION**

Single-Stage: Two-Envelope Bidding Procedure  
Without Prequalification

**BID Package Number: SDN/BREB/W-14**  
**(Package Number: P-6 as per ADB's Procurement Plan)**

**Volume: 2 of 3**

**Project: Strengthening of Distribution Network for  
13PBS's Surrounding Dhaka City Under REB Project;  
Financed by Asian Development Bank**



ISO 9001, ISO 14001 &  
ISO 45001 Certified

**Bangladesh Rural Electrification Board  
6<sup>th</sup> Floor, Head Quarter Building,  
Bangladesh Rural Electrification Board,  
Nikunja-2, Khilkhet, Dhaka-1229, Bangladesh**

**Asian Development Bank  
June 2026**

## **Section 6: Employer's Requirements**

This section contains the Scope, the Specifications, the Drawings, and Supplementary Information that describe the Facilities and Forms to be used during the implementation of the contract, as well as the Contract Management Plan, and the Personnel, Equipment, Project Signage and Environmental, Health, and Safety (EHS) requirements. This section should not contain commercial or contract conditions that are stipulated in other parts of the Bidding Document.

In a design, supply, and installation approach, the design is to be done by the Contractor. No detailed technical specification as normally practiced is developed at the pre-bid stage. However, the Employer does and must know what it wants and must communicate its needs to the Bidders. Hence, this section on Employer's Requirements replaces the usual Technical Specifications of a more traditional approach.

To enable Bidders to submit responsive bids and, subsequently, for the bids received to be evaluated in an equitable manner, the Employer must make its requirements clear and precise. The Employer's requirements must therefore, specify the exact requirements of the completed Facilities. Where the performance of the completed Facilities could be measured in quantitative terms, such as production output of a manufacturing plant or maximum generating capacity of a power station, the Employer's Requirements should not only clearly specify the desired output and/or capacity but also the upper and lower acceptable limits of deviation from the desired capacity and how such deviations (if any) will be evaluated. It will also be necessary to specify the tests to be carried out upon completion of the Facilities to verify compliance with the specified requirements. The Employer's Requirements should also clearly list the associated or incidental services and goods that must be supplied by the Contractor. For example, the Contractor may be required to train the Employer's personnel and to supply consumable or spare parts as listed in a schedule.

While this section of the Bidding Document should endeavor to define the Employer's Requirements as precisely as possible, care must be taken to avoid over specifying details to the extent that the flexibility and potential benefits associated with a design, supply, and installation contract are seriously eroded or threatened. This section on Employer's Requirements should, therefore, be carefully prepared on behalf of the Employer by suitably qualified engineers who are familiar with the requirements and with the technical aspect of the required Facilities.

For an ADB-financed design, supply, and installation contract to be procured through open competitive bidding procedures, the Employer's Requirements must be drawn up to permit the widest possible competition and, at the same time, present a clear statement of the required standards of workmanship, materials, and performance of the Facilities. Only if this is done will the objectives of economy and efficiency, fairness, and transparency in procurement be realized, responsiveness of bids be ensured, and the subsequent task of bid evaluation facilitated. The Employer's Requirements should stipulate that all goods and materials to be incorporated in the Facilities are new, unused, of the most recent or current models, and should incorporate the latest improvements in design and materials.

# Table of Contents

|                                                                                       |           |
|---------------------------------------------------------------------------------------|-----------|
| Section 6: Employer's Requirements .....                                              | 2         |
| Table of Contents .....                                                               | 3         |
| 1. Project Signage Requirements .....                                                 | 4         |
| 2. Environmental, Health, and Safety Management Requirements .....                    | 5         |
| 3. Specifications .....                                                               | 6         |
| 1. TECHNICAL SPECIFICATIONS .....                                                     | 6         |
| Description .....                                                                     | 7         |
| <b>2.0 Particular Technical Requirements for Substation Electrical Equipment.....</b> | <b>48</b> |
| SUBSTATION EARTHING SYSTEM.....                                                       | 215       |
| A. ELECTRICAL.....                                                                    | 286       |
| 3.0 TESTING AND COMMISSIONING .....                                                   | 286       |
| B. CIVIL.....                                                                         | 308       |
| B. CIVIL.....                                                                         | 328       |
| B. CIVIL.....                                                                         | 383       |
| B. CIVIL.....                                                                         | 397       |
| C. MISCELLANEOUS .....                                                                | 416       |
| C. MISCELLANEOUS .....                                                                | 420       |
| C. MISCELLANEOUS .....                                                                | 422       |
| 10.0 CONTROL ROOM FURNITURE.....                                                      | 422       |
| C. MISCELLANEOUS .....                                                                | 425       |
| 9. Appendix .....                                                                     | 429       |
| 4. Drawings.....                                                                      | 430       |
| 5. Supplementary Information .....                                                    | 433       |
| 6. Certificates.....                                                                  | 434       |
| 7. Change Orders.....                                                                 | 437       |
| 8. Personnel Requirements.....                                                        | 447       |
| 9. Equipment Requirements.....                                                        | 449       |
| 10. Contract Management Plan .....                                                    | 450       |

# 1. Project Signage Requirements

## NOTE

*To ensure that project information is visible to the public during the execution of works under the project and that there is a precise acknowledgment of the funding source, the Employer's team preparing the project signage requirements at site should ensure they follow the Country's regulations on the display of project signage at the site, where available. These requirements will be reviewed and may be adjusted based on due diligence conducted during project processing, including when projects are cofinanced, among others.*

*If the applicable Law does not have such regulations, ADB requirements shall be followed. Employer should seek Project Manager's support in defining site-specific requirements such as visibility and use of materials, and others. It is the responsibility of the Contractor to comply with these requirements and the Project Manager shall ensure its compliance during contract execution and include information in progress reports.*

*Below is a sample text provided for guidance and may be modified as per the project-specific requirements.*

1. The Contractor is responsible for the design, supply and installation of the project information signage. The signage shall provide relevant information to the public about the project, including the proper designation of the project, the Employer, the Contractor and the Bank.
2. For this purpose, one or several sign boards shall be installed at the Site as soon as practicable after the Commencement Date and shall remain in place at all times until taking-over of the Works. If sign board(s) is(are) damaged or becomes unreadable during this period, it shall be promptly replaced by the Contractor at the Contractor's cost.
3. The sign board design shall be submitted by the Contractor to the Project Manager for Review in accordance with Sub-Clause 4.4.6 [*Sign Board Design*]. Unless otherwise required under the applicable Laws, the sign board design should comply with the following:
  - a) General
    - The number and locations of sign board(s)
  - b) Content
    - Borrowing Country's flag and/or logo
    - Project and Contract title
    - Accepted Contract Amount
    - Time for Completion
    - Bank's name and logo (in accordance with Branding Tool Kit – Visual Identity guidelines of the Asian Development Bank and, as the case may be, the other financiers' requirements)
    - Employer's name
    - Contractor's name
    - Project Manager's name
    - Complaint handling contact information (email and/ or phone number)
  - c) Design
    - The General layout including sample colors: to be proposed by the Contractor
    - Dimensions: minimum of 2.5 Meters X 2.5 Meters
    - Font size and type: they should be such as to ensure that the content shall be visible from a distance.
    - Language of the signage: national and/or local language and English
    - Material: the sign board(s) shall be made of a material that shall be weatherproof and appropriate to withstand the whole execution period until taking-over of the Works
4. No other signage is allowed except with the approval of the Project Manager. The Contractor shall not post nor display any sign or item that could provide misleading information about the project. No national symbols or flags other than those of the Country may be displayed without the express approval of the Project Manager.



## 2. Environmental, Health, and Safety Management Requirements<sup>1</sup>

### (Attached Volume-3)

#### NOTES

*The Employer's team preparing the Environmental, Health, and Safety (EHS) requirements should include a suitably qualified EHS specialist/s as determined by the Environmental Management Plan (EMP). The Employer should attach or refer to the Employer's environmental, health, and safety policies that will apply to the project, if available.*

*Based on the required environmental assessment undertaken for the project<sup>2</sup> and this specific contract, the Employer shall provide key EHS risks and impacts and expectations on contractors to manage the risks and impacts. This may include, as appropriate, but not be limited to a summary of: key expectations in managing labor and working conditions, protection of the environment, health, and safety and security of the site, community health and safety, management of safety of hazardous materials, resource efficiency and pollution prevention and management, biodiversity conservation and sustainable management of living natural resources, and others. Any summary (key) information provided here shall not be inconsistent with the more detailed requirements in the Bidding Document.*

*The Employer should highlight the requirement of a Site-Specific Environmental, Health, and Safety Management Plan (SSEMP/SSHSM) to be prepared based on the outline Environmental, Health, and Safety Management Plan (EHSMP) submitted as part of the Contractor's technical proposal. The SSEMP/SSHSM shall be submitted within the contractual timeline outlined in the Contract Conditions. The Engineer or Project Manager shall endeavor to issue a no-objection to the SSEMP/SSHSM within a prescribed period upon receipt of the SSEMP/SSHSM, if the EHS requirements for the plan are met. No physical works shall commence on-site prior to the confirmation of no-objection to the SSEMP/SSHSM obtained from the Engineer as per Contract Conditions*

#### **Minimum Content of Requirements**

*In preparing detailed specifications for requirements, the specialists should refer to and consider:*

- project reports. e.g. Environmental Impact Assessment (EIA) or Initial Environmental Examination (IEE), EMP (as applicable);*
- consent or permit conditions;*
- required standards including ADB Safeguard Policy Statement and related EHS Guidelines;*
- relevant international conventions or treaties, and others, national legal and/or regulatory requirements and standards (where these represent higher standards than the ADB Guidelines);*
- relevant international standards, e.g., World Health Organization (WHO) Guidelines for Safe Use of Pesticides;*
- relevant sector standards, e.g., European Union (EU) Council Directive 91/271/EEC Concerning Urban Waste Water Treatment;*
- grievance redress mechanism, including types of grievances to be recorded and how to protect confidentiality; and*
- Control of infectious and communicable diseases (HIV/AIDS, malaria, COVID-19, and others)*

*Any summary (key) information provided here shall not be inconsistent with the more detailed requirements in the Bidding Document.*

*The detailed specification for EHS should, to the extent possible, describe the intended outcome rather than the method of working.*

*The EHS requirements should be prepared in a manner that does not conflict with the relevant General Conditions of Contract (and the corresponding Particular Conditions, if any) and other parts of the specifications.*

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<sup>1</sup> For projects categorized as Category C for environment for which no EMP has been prepared, there is no need to consider the Notes on this page.

<sup>2</sup> Category A projects for environment are considered to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented and such projects will require a full-scale environmental impact assessment (EIA), including an environmental management plan (EMP). Category B projects for environment are considered to have environmental impacts that are less adverse and fewer in number than those in Category A and such projects will require an initial environmental examination (IEE), including an EMP.

## **3. Specifications**

### **1. TECHNICAL SPECIFICATIONS**

# **TABLE OF CONTENTS**

## *Description*

### **A.** Electrical

- 1.0 General Technical Requirements for Substation Electrical Equipment
- 2.0 Particular Technical Requirements for Substation Electrical Equipment
- 3.0 Testing and Commissioning

### **B.** Civil - Technical Requirements for Substation Civil and Building Works

- 4.0 General Technical Requirements
- 5.0 Substation Building and Ancillary Facilities
- 6.0 Sanitary and Water Supply Works
- 7.0 Internal and External Electrification

### **C.** Miscellaneous

- 8.0 Desktop/ Laptop Computer & Accessories
- 9.0 Air Conditioner
- 10.0 Control Room Furniture
- 11.0 Fire Detection & Protection Facilities

## A. ELECTRICAL

### 1.0 GENERAL TECHNICAL REQUIREMENTS FOR SUBSTATION ELECTRICAL EQUIPMENT



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## TABLE OF CONTENTS

| <b>Clause No.</b> | <b>1.41 Description</b>                                           |
|-------------------|-------------------------------------------------------------------|
|                   | General Technical Requirements-Electrical                         |
| 1.0               | Introduction                                                      |
| 1.1               | System Parameters                                                 |
| 1.2               | Climatic Conditions                                               |
| 1.3               | Management Systems                                                |
| 1.4               | Standards                                                         |
| 1.5               | Standards and Code Not Specified Units                            |
| 1.6               | of Measurement                                                    |
| 1.7               | Facilities and Transport to Site Documentation                    |
| 1.8               | Erection and Checking at Site                                     |
| 1.9               | Contractor's Responsibilities                                     |
| 1.10              | Sub-contracts and Orders                                          |
| 1.11              | Packing and Erection Marks                                        |
| 1.12              | Contractor's Local Agent Civil                                    |
| 1.13              | and Building Works                                                |
| 1.14              | Design and Construction Requirements and Interchangeability Plant |
| 1.15              | and Equipment Identification                                      |
| 1.16              | Safety and Security                                               |
| 1.17              | Spare Parts                                                       |
| 1.18              | Consumable Items                                                  |
| 1.19              | Painting and Cleaning                                             |
| 1.20              | Galvanized Work                                                   |
| 1.21              | Mechanical Items                                                  |
| 1.22              | Electrical Insulation                                             |
| 1.23              | L.V. Circuit Protection                                           |
| 1.24              | Electrical Equipment, Instruments and Meters Control              |
| 1.25              | and Selector Switches                                             |
| 1.26              | Auxiliary Switches                                                |
| 1.27              | Alarm Equipment                                                   |
| 1.28              | Panels, Desks, Kiosks and Cubicles                                |
| 1.29              | Panel Wiring and Terminal Boards                                  |
| 1.30              | Cable Boxes and Glands                                            |
| 1.31              | Joints and Gaskets                                                |
| 1.32              | Junction, Termination Marshalling Boxes, Operating Cubicles etc.  |
| 1.33              | Conduit and Accessories                                           |
| 1.34              | Trunking                                                          |
| 1.35              | Push-Buttons and Separately Mounted Push-Button Stations          |
| 1.36              | Drawings, Diagrams and Calculations                               |
| 1.37              | Operating and Maintenance Manuals                                 |
| 1.38              | Site Storage Facilities Switchyard Cable Ducts and Conduits       |
| 1.39              |                                                                   |
| 1.40              |                                                                   |

## *IMPORTANT INSTRUCTION TO BIDDER*

**In case of any bids offer goods as equivalent quality from a country and manufacturer instead of a country and manufacturer specified in Section-6 (Employer's Requirements), then the following additional condition shall be met:**

The manufacturer must have at least 30 years manufacturing experience of the offered goods and those goods must have overall satisfactory operation in Bangladesh or any other South Asian Countries (Except manufacturers own country) at least 15 years counting backward from the date of bid submission. Goods offered as equivalent quality shall have a complete type test report as per the standard specified in Section-6 from any member of STL testing laboratory. Goods offered as equivalent quality must have synchronize/matching capability with the existing network of BREB to ensure changeability and reliability. As a proof of evidence bidder must submit manufacturing documents for 30 years with production capacity, Delivery records for 30 years, Operational acceptance certificate and at least 5 nos. End User Certificate from electricity utility about the satisfactory operation of said duration and also routine test report, type test certificate along with test reports on the user's/relevant letterhead, indicating address, telephone and fax numbers, e-mail address, project name, employer's name, description of work, commissioning date and contract date & amount shall be provided in the bid. All the evidence other than in English Language must be translated into English and the translation shall be certified by the Notary public or Government Authorized agency of the bidder's country. Bidder also shall submit relevant documents which prove that the offered goods are equivalent with respect to the goods of a country and manufacturer specified in Section-6. If any bidder fails to submit any of the above documents, then the bid shall be rejected. Please note that employers may accept or reject the goods offered as equivalent without any clarification/ justification."

## 1.0 General Technical Requirement - Electrical

### 1.0.1 Introduction

This section describes the General Technical Requirements for the assembly, construction, supply, installation, test and commissioning of new BERB 33/11 kV indoor type substations and general switchyard equipment, and shall be read in conjunction with the project requirements, schedules and drawings in the specification.

The Contractor shall demonstrate that the equipment has been designed, built and installed in accordance with the relevant international standards and the specification. It shall also operate and perform on a site in accordance with the requirements of the specification and in the environment defined herein.

The design shall be proven by the submission of test certificates at the time of bidding, in accordance with the relevant standards, covering all specified tests deemed to be pertinent to the plant and to the conditions in which it will operate or, if such test certificates cannot be supplied or are deemed unacceptable by the Project Manager, type tests which will be subject to the conditions of this Contract shall be carried out at no extra cost to the Employer.

Type test certificates shall be from an internationally accredited independent testing laboratory such as KEMA- Netherlands; CESI- Italy; Underwriters Laboratory (UL)-USA or CPRI-India. Proof of accreditation shall be provided with the certificate for any other laboratory.

The requirement for switchgear spares, tools and appliances, including test, maintenance and handling equipment shall be as stated in the bidding document. All devices necessary for operation and earthing shall be provided within the contract price.

### 1.1 System

#### Parameters

#### Electrical Network

| Parameters:                      | Network          |                               |                |
|----------------------------------|------------------|-------------------------------|----------------|
|                                  | 33 kV            | 11 kV                         | 0.4 kV Aux.    |
| Nominal Voltage                  | 33kV             | 11 kV                         | 0.4/0.23 kV    |
| Rated System Voltage             | 33 kV            | 11.55 kV                      | 0.415/0.240 KV |
| Highest System Voltage           | 36 kV            | 12 kV                         | 0.440 kV       |
| Number of Phases                 | 3                | 3phase 4 wire with PME system | 3 ph,4 wire    |
| Frequency                        | 50Hz             | 50Hz                          | 50Hz           |
| Neutral Point                    | Effective        | Solid                         | Solid          |
| 3 Phase Short Circuit Capability | Earthing 31.5 kA | Earthing 31.5 kA              | Earthing 12 kA |
| Duration of Short Circuit        |                  |                               |                |
| For power transformers           | 3sec             | 3sec                          | 3sec           |
| For other electrical equipment   | 3sec             | 3sec                          | 3sec           |



| Parameter                                                                                                     | Network                      |                      |             |
|---------------------------------------------------------------------------------------------------------------|------------------------------|----------------------|-------------|
|                                                                                                               | 33 kV                        | 11 kV                | 0.4 kV Aux. |
| Impulse Withstand Voltage                                                                                     |                              |                      |             |
| For Substation Equipment                                                                                      | 170 kVp                      | 75 kVp               |             |
| For Neutral Point -Transformer                                                                                | 75 kVp                       | 28 kV                |             |
| Power Freq. Withstand Voltage                                                                                 |                              |                      |             |
| For Substation Equipment                                                                                      | 75 kV                        | 28 kV                | 2 kV        |
| For Transformer Windings                                                                                      | 70 kV                        | 28 kV                | 2 kV        |
| For Neutral Point -Equipment                                                                                  | 50 kV                        | 28 kV                | 2 kV        |
| For Neutral Point -Transformer                                                                                | 70 kV                        | 28 kV                | 2 kV        |
| Min creepage distance (mm/kV)<br>for highest rated voltage                                                    |                              |                      |             |
| Indoor exposed insulators                                                                                     | 20 mm                        | 20 mm                |             |
| Outdoor exposed insulators                                                                                    | 25 mm                        | 25 mm                |             |
| Minimum clearance in air                                                                                      | In accordance with IEC 60071 |                      |             |
| Minimum clearance between<br>walkway<br>and the lowest live point                                             | 2750 mm                      | 2590 mm              |             |
| Minimum safety clearance<br>between ground and the lowest<br>point not at earth<br>potential of any insulator | 2500 mm<br>(Outdoor)         | 2500 mm<br>(Outdoor) |             |
| Minimum clearance between live<br>parts<br>and earth                                                          | 381 mm                       | 200 mm               |             |
| Minimum clearance between<br>live fixed metal of different<br>phases                                          | 432 mm                       | 250 mm               |             |

### Electrical Station Services:

|                                   |                                                                                  |
|-----------------------------------|----------------------------------------------------------------------------------|
| A.C.                              | Nominally 415 V $\pm$ 10%, 4 wire system. Refer 1.2.1 below.                     |
| D.C. (Control & Protection)       | 110 Volt nominal tolerance on rated voltage + 10% to -15%                        |
| Main station service transformers | 33,000/415 Volts $\pm$ 10% /Y aux complete with 415 Volt fused isolating switch. |

#### 1.1.1 Design of Low Voltage AC System

The design of the LV AC power and control system within the substation shall take into account the possible variations in the incoming 33 kV voltage. The auxiliary supply transformer is connected to the 33 kV voltage to ensure that an auxiliary supply is available even when the power transformer is off line. However, this means that the LV AC system is subject to the possible variation of the incoming 33 kV voltage. This voltage may vary from 24 kV up to a maximum of 36 kV.

The LV AC system in the substation, including the off load tapping range of the 33,000/415 V auxiliary transformer, the operating voltages of motors and contactors as well as any AC control systems shall be designed to cater for the above variation.

## 1.2 Climatic Conditions

**Instructions to Bidders:** The information in this clause is given solely for the general assistance of bidders and no responsibility for it will be accepted nor will any claims based on this clause be considered.

All plant and equipment supplied under the Contract shall be entirely suitable for the climatic conditions prevailing at site. Atmospheric pollution is mid-level and special insulator design or washing is not required. The area is subject to high winds of typhoon strength.

### Topographical and Meteorological Site Conditions

| Site Location                                                                              | Unit      | Various locations in Dhaka Division. |
|--------------------------------------------------------------------------------------------|-----------|--------------------------------------|
| Max design Altitude for all equipment operating characteristics as per IEC above sea level | m         | 1000                                 |
| <b>Air Temperatures</b>                                                                    |           |                                      |
| - Maximum Peak (Design maximum ambient temperature)                                        | °C        | 45                                   |
| - Maximum daily average                                                                    | °C        | 35                                   |
| - Maximum yearly average                                                                   | °C        | 30                                   |
| - Minimum                                                                                  | °C        | 4                                    |
| Sun temperature in direct sunlight                                                         | °C        | Max. 40                              |
| Maximum ground temp at depth of 1000mm                                                     | °C        | 30                                   |
| <b>Humidity</b>                                                                            |           |                                      |
| Maximum relative humidity at 40degrees                                                     | %         | 100                                  |
| Minimum relative humidity                                                                  | %         | 50                                   |
| Yearly average                                                                             | %         | 80                                   |
| <b>Pollution level</b>                                                                     |           |                                      |
| Outdoor                                                                                    |           | Medium                               |
| Indoor                                                                                     |           | Medium                               |
| Dust Storms                                                                                | days/annu | 30                                   |
| Average number of days per year of thunder storms                                          | days/yr   | 80                                   |
| Maximum wind velocity (for design purposes)                                                | km/hr     | 200 (3 sec gust)                     |
| Minimum wind velocity for line rating purposes(33kV)                                       | Km/hr     | 1.6                                  |
| Solar radiation                                                                            | mW/sq.    | 100                                  |
| Ice loading, radial thickness                                                              | mm        | N/A                                  |
| Total rainfall                                                                             | m/Annu m  | 1.5                                  |
| Seismic factor (The area is designated a zone of moderate intensity for earthquakes.)      | gm        | 1.5                                  |
| Soil Type                                                                                  |           | alluvial                             |
| Soil temperature (at 1.1m)                                                                 | °C        | 30                                   |
| Soil thermal resistivity                                                                   | °C m/w    | 1.5                                  |

## **1.3 Management Systems**

### **1.3.1 General**

The Contractor shall carry out the Works in accordance with sound quality and environmental management principles, and in particular shall have management systems which conform to the requirements of the ISO 9000 family of standards for Quality Management and the ISO 14000 family of standards for Environmental Management.

These quality management requirements shall apply to all activities including design, procurement, manufacturing, inspection, testing, packing, shipping, storage, site erection and commissioning.

The Contractor, major sub-contractors and suppliers shall have Quality Systems certified as complying with the requirements of ISO 9001 applicable to sales, design, construction and commissioning of high- and medium-voltage substations. If minor sub-contractors and suppliers do not have such systems then the Contractor's Quality System shall be deemed to apply.

It is preferred that the Bidder be certified as complying with ISO 14001 but this is not a qualifying requirement.

Documents submitted by the Bidder, including those provided by sub-contractors, will not be accepted unless they include evidence that they have been verified by the Bidder.

### **1.3.2 Quality Documentation and Audit**

The Contractor shall submit a copy of its Quality Manual and relevant quality procedures, in the English language, within one (1) month of the Effective Date of the Contract. Quality Manuals from sub-contractor and suppliers shall be submitted within two (2) weeks of the Contractor making a commitment to them.

The Contractor shall clearly identify all quality records that will be used for the Contract.

The Employer may undertake an inspection or quality audit of the Contractor's or sub-contractor's facilities at any time. Full quality records of procurement and manufacture shall be made available at the start of factory inspection and testing of equipment. Full quality records to the completion of installation shall be made available before the start of site testing.

### **1.3.3 Quality Plan**

The Contractor shall ensure that its quality procedures address all requirements of the Specification. The Contractor shall ensure that the quality procedures of sub-contractor, manufacturers and suppliers address all requirements of the Specification, and that the Contractor's quality procedures provide verification of this.

The Contractor shall prepare an overall Quality Plan for the Works, and shall provide detailed quality plans for all major sub-contractors and suppliers.

**Quality plans shall include:**

Organization chart with identification and details of key personnel;

Inspection and Test Plans on which hold points and recommended inspections by the Employer are clearly shown.

Quality Plans shall be subject to the approval of the Employer. An initial Quality Plan shall be submitted with one (1) month of the Effective Date of the Contract. A revised Quality Plan which includes full details of all Inspection and Test Plans shall be submitted within two (2) months of the Effective Date of the Contract.

Not less than two (2) months prior to mobilization to Site, the Contractor shall submit the Quality Plan revised to include a complete list of all site personnel detailing names, positions and responsibilities complete with an organization chart. The Contractor shall provide for approval full details, including curriculum vitae, of all engineering, technical and other key staff to be employed at site. Personnel shall not mobilize to Site prior to approval being given.

**1.3.4 Measuring and Testing Equipment**

All measuring and testing equipment shall have current calibration certification. Use of measuring and test equipment which is demonstrated to be calibrated against equipment which has such certification may be accepted.

**1.3.5 Inspection and Test Records**

The Contractor shall compile the reports of all factory and site tests into a volume of the Operation and Maintenance Manuals.

**1.3.6 Equipment Identification and Preservation**

The Contractor shall establish and maintain a system for the identification, preservation, segregation and handling of all equipment from receipt through manufacturing, dispatch, storage and installation to prevent abuse, misuse, damage, or deterioration by corrosion through exposure to air or moisture.

**1.4 Standards**

In the technical specification references have been made to various clauses of IEC; BS; ISO and ASTM and ANSI standards. Where any standard referred to in this specification has been superseded by a new standard the reference shall be deemed to be to such superseding standards. Notwithstanding the standard numbers mentioned in the technical specification the bidders are directed to apply the latest published editions of these standards.

Deviations from the specified standards referred to above shall be given in a Schedule of Proposed Standards and shall have to be accepted by the Employer before contract placement.

## **1.5 Standards and Code Not Specified**

Where not specified, the IEC Standard and the Bangladesh National Building Code (BNBC) shall be applicable.

## **1.6 Units of Measurement**

In all correspondence, in all technical schedules, on all drawings and for all instrument scales, S.I. units of measurement are to be employed. Angular measurement shall be in degrees with 90 degrees forming a right angle.

## **1.7 Facilities and Transport to Site**

Chittagong & Mongla sea ports and Benapole land port are the principal port of entry for material to Bangladesh. The contractor shall provide his own storage facilities, security, insurance etc.

The Contractor is responsible for performing all unloading, inland transportation and obtaining all approvals and consents etc. necessary for the movement of plant and Contractor's equipment from the port to the site.

All necessary access roads, jetties or off-loading points etc. required for the transport of the plant etc. to site will be the Contractors responsibility.

Where heavy loads are to be moved the Contractor shall be responsible for performing surveys of the routes to ensure that all portions have adequate load-bearing capacity.

A comprehensive method statement shall be submitted to the Project Manager detailing the proposed transport route(s) and requirements. Plans indicating all bridges, ducts, culverts, railway crossings, overhead lines, water mains etc. their load bearing capacity or clearances as appropriate shall be given together with proposed means of achieving the transportation requirements. Any reinforcement, strengthening, modifications or temporary works required to obtain the necessary capacity shall be the responsibility of the Contractor. The cost of the above is to be included in the Bid price.

No plant is to be consigned to Bangladesh by airfreight without the prior written approval of the Employer.

## **1.8 Documentation**

### **1.8.1 Documentation**

In order for the Employer to obtain the necessary import permits and satisfy the requirements of the customs authorities the following documentation is required.

Within 60 days of the effective date of Contract, the Contractor shall submit a detailed schedule of plant that is to be provided under the Contract indicating the type of equipment and the name of the

manufacturer. Six copies of the schedule are to be submitted to the Project Manager and the Employer.

## **1.9 Erection and Checking at Site**

As each part of the works is erected, the Contractor shall seek the Employer's approval that the works have been constructed in accordance with the specification and approved drawings.

For purposes of progress payments for site work a monthly and cumulative system of joint measurement of work done for each section of work shall be set up by the Contractor in a manner approved by the Employer.

Any works constructed prior to the issue of drawings approved by the Employer for the particular works may not be included in the percentage completion figures.

The Contractor is to provide such protection and watchmen as may be considered necessary to safeguard his materials and stores. The Employer will not accept responsibility for any loss or damage, which may occur during the execution of the Contract.

The carrying out of all the work included in the Contract shall be supervised by a sufficient number of qualified representatives of the Contractor, and full facilities and assistance shall be provided to the Employer to check the works. The Contractor shall obtain from the Employer details of the works that he proposes to inspect, but such inspection shall in no way exonerate the Contractor from any of his obligations. The Contractor, if required by the Employer, shall open for inspection before erection any equipment, which has been delivered to the site partly assembled.

On completion of the works the site shall be left clean and tidy to the satisfaction of the Employer. Any damage done to buildings, structures, plant or property belonging to the Employer shall be made good at the Contractor's expense.

The Contractor shall ensure the correctness of electrical and mechanical connections to all equipment supplied under the contract before such equipment is commissioned.

During erection and commissioning the Contractor shall provide all temporary scaffolding, ladders, platforms with toe boards and hand-rails essential for proper access of workmen and inspectors, cover or rail off dangerous opening or holes in floors, and afford adequate protection against materials falling from a higher level on a person below.

The maximum personal safety must be afforded to personnel either directly engaged on this Contract or who in the normal course of their occupations find it necessary to utilize temporary works erected by the Contractor or to frequent the working area.

In each and every case involving a connection between the plant supplied under this Contract and any other existing plant which may or may not be in service, the Contractor must make suitable arrangements as regards the time and manner in which the connection is made subject to the approval of Employer's Representative who is in charge of the existing plant. Where cases arise involving the operation of the plant or work on plant in operation or whenever required by the Employer's Representative, the Contractor must obtain a written "Permit to Work" signed by a person duly authorized by the Employer.

## **1.10 Contractor's Responsibilities**

### **1.10.1 Planning of Works**

Within 30 days after the effective date of Contract, the Contractor shall prepare, in an agreed form, a detailed manufacture, delivery and erection program chart for the complete Contract works, and shall submit the chart to the Employer for approval.

The manufacture, delivery and erection program chart shall indicate for each major item of the Contract the various phases of work from the commencement of the Contract to its completion, e.g., design, ordering of materials, manufacture, delivery, installation and commissioning. The program shall include a fully comprehensive drawings production program which shall demonstrate the Contractor's intended issue dates for approval.

These presentations shall be in bar chart and precedence critical path analysis format. The program shall indicate percentage completion points of the various phases which can form the basis of progress reporting.

A cash-flow forecast of the estimated monthly invoice values shall be included in the program. This forecast shall take into account the terms of payment and indicate down-payments, release of retention's, etc. Figures may be rounded to the nearest thousands of the appropriate currency.

The Contractor shall indicate in the program the number, grade and discipline of supervisory and managerial site staff proposed throughout the site construction periods. If specialist erection and commissioning staff are to be employed by the Contractor details of the number, discipline and duration of visit of these staff are to be indicated in the program. The provision of this information will not form any contractual limit on the number of staff to be provided by the Contractor to ensure the timely completion of the Contract. Should any incident occur which, in the opinion of the Contractor will result in an over-run of any section of the Works this shall be indicated in the program and brought to the Employer's attention.

If, at any time during the execution of the Contract, it is found necessary to modify the approved manufacture, delivery and erection program chart, the Contractor shall inform the Employer and submit a modified chart for his approval. The submission, and subsequent approval, of a modified manufacture, delivery and erection program chart shall not necessarily obviate or diminish the Contractor's responsibilities and liabilities under the Contract. The chart shall be updated at monthly intervals and submitted to the Employer no later than the middle of each calendar month.

### **1.10.2 Progress Reports and Meetings**

At monthly intervals after approval of the plant manufacture, delivery and erection program chart, the Contractor shall submit to the Employer updated bar chart programs and precedence critical path analysis networks in triplicate in an approved format indicating the stage reached in the design, ordering of material, manufacture, delivery and erection of all components of plant. In addition, the Contractor will compile and submit "S-curves" based upon the approved program indicating programmed and actual percentage completion of the various stages of drawing approval, manufacture, shipping, civil works and erection for each section of the works plus the overall Contract.

An updated cash-flow forecast indicating previously forecast and actual, involving levels together with revised future requirements shall be submitted quarterly. A graphical display in the form of an "S-curve" of the actual vs. planned payment certification (on & offshore) shall be provided by the Contractor in triplicate on a quarterly basis to supplement the basic cash flow information.

If, during execution of the Contract, the Employer considers the progress position of any section of the work to be unsatisfactory, or for any other reason relating to the Contract, he will be at liberty to call meetings, either in his head office or at site. If required by the Employer, a responsible representative from the Contractor is to attend at the Contractor's expense such meetings with

sufficient authority to issue instructions or effect an alteration in the works to the satisfaction of the Employer. Access to the Contractor's and Sub-contractor's works is to be granted to the Employers representative at all reasonable times for the purpose of ascertaining progress.

### **1.11 Sub-contracts and Orders**

As soon as practicable after entering into the Contract the Contractor may, having obtained the Project Manager's consent, enter into the sub-contracts he considers necessary, for the satisfactory completion of the Contract works. Three un-priced copies of the Contractor's sub-orders shall be supplied to the Project Manager.

One copy of any drawings where the sub-order shall refer shall also be submitted. Each sub-order and drawing shall contain the following reference and an instruction that the plant is subject to inspection and tests to be witnessed by the Project Manager or his agent with sufficient authority to issue instructions, or effect an alteration in the works to the satisfaction of the Project Manager. Approval by the Project Manager of Contractor's sub-orders shall not relieve the Contractor of his responsibilities in meeting this specification. It is the Contractor's responsibility to ensure that a full specification based on the relevant information in the Contract is passed to the sub-contractor.

The Contractor will be responsible for progressing the Sub-contractor's works including visits to the works to ensure the work as to programme, specification, quality and drawings and to witness all necessary routine, sample and type tests. The cost of this Contract control is deemed to be included in the Contract sum.

### **1.12 Packing and Erection Marks**

Each item is to be export packed and properly protected for shipment, transport and storage in the port area and for transport to and storage on site.

**All Plant provided under this Contract shall have the packing marked in the following manner.**

A green band shall be painted all around each package. The band shall be 8" wide or 1/4 of the length of the packing whichever is the less. Each package should have the following information printed on it in bold letters: -

- (a) Port of Loading
- (b) Name of Consignee
- (c) Purchase Order  
Number
- (d) Brief description  
of Stores
- (e) Number of Package
- (f) Gross, tare and net  
weight
- (g) Measurements
- (h) Contractors Name
- (i) Contract Title
- (j) Contract Number
- (k) Port of Landing

All members comprising multi-part assemblies, e.g., steel frameworks, are to be marked with distinguishing numbers and/or letters corresponding to those of the approved drawings or materials lists.



Color banding to and approved code is to be employed to identify members of similar shape or type but of differing strengths or grades.

Cases containing delicate items such as relays and instruments should carry a separate marking: Sensitive equipment packages shall be opened in the presence of a representative of the Employer.

### **1.13 Contractor's Local Agent**

**Instruction to Bidder:** The Bidder shall state in his bid the name and address in Bangladesh of his local Agent, if any. All bidders must have operation and maintenance facilities in Employer's Country for after sales service support. However, bidder from outside the Employer's country shall submit the name & address of a local agent who is able to liaise with the Employer. And also, the local agent shall be responsible along with bidder to provide proper service up to extended warranty period. Such local agent must have enough similar experience (including qualified expert who has experience on installation, testing and commissioning works for GIS) to provide services as per the Employer's requirements up to the extended warranty period. Bidder shall submit along with the bid a confirmation letter issued from that local agent and also relevant documents of experience. The bidder shall submit an agreement copy with the local agent before signing this contract if the contract is awarded.

### **1.14 Civil and Building Works**

Where items of mechanical plant are mounted on foundations, which are part of the civil engineering works, the Contractor shall carry out suitable leveling and adjustment of the plant on the foundations, before the plant is secured in position. The Contractor shall check the alignment, leveling or positioning of the mechanical plant in question, before and after grooving. The Contractor shall make records of the alignment, leveling or positional measurement and shall maintain such records until his activities at site are concluded. The building steel work shall be designed to carry the loads/forces imposed by pipe work, cables and associated fittings which also form part of the works, and all necessary supports and fixing shall be shown on the relevant drawings. Such supports and fixings may be secured to the steel work by bolting welding or clamping. No other supports or fixings shall be subsequently attached to the steel work nor may any other drilling, cutting or welding be carried out without the prior permission of the Project Manager.

### **1.15 Design and Construction Requirements and Interchangeability**

#### **1.15.1 General Requirements**

The Works shall be designed to operate safely, reliably and efficiently in accordance with the design and operating requirements stated in this specification.

No departure from the specification shall be made subsequent to the Contract without the written approval of the Employer with the recommendation of the Project Manager.

The design shall conform to the best current engineering practice. Each of the several parts of the plant shall be of the maker's standard design, provided that this design is in general accordance with the specification.

The design, dimensions and materials of all parts shall be such that they will not suffer damage as a result of stresses under the most severe service conditions. The materials used in the construction of the plant shall be of the highest quality and selected particularly to meet the duties required of them. The plant shall be designed and constructed to minimize correction. Workmanship and general finish shall be of the highest class throughout.

All plant items and corresponding parts forming similar duties shall be interchangeable in order to minimize the stock of spare parts.

All equipment shall be designed to minimize the risk of fire and damage which may be caused in the event of fire.

### **1.15.2 Specific Requirements**

The choice of plant and design of the installation is to meet the following criteria. Sub-station layouts are to utilize the minimum of land area. All equipment is to facilitate the installation of all circuits indicated as "future" with the minimum of disruption. All cabling schemes, D.C. and A.C. equipment etc. shall be designed to accommodate all such future circuits, loads, etc.

The plant and installation shall be designed for a minimum service life of 25 years.

All plant is to have a minimum of 2 years satisfactory and proven service record of high durability and reliability in a similar environment. Documentary evidence in support of the choice of any item of plant shall be provided by the Contractor if requested by the Project Manager.

Each sub-station is to be designed such that the failure or removal of any one item of plant for maintenance or repair shall not impair the operational integrity of the sub-station.

The design and layout of the sub-stations shall ensure the safety of personnel concerned with the operation and maintenance of the plant.

## **1.16 Plant and Equipment Identification**

### **1.16.1 Identification on Drawings**

The Contractor shall prepare comprehensive plant or equipment identification schedules. The schedules shall include the respective flow sheet or drawing/diagram identification numbers.

### **1.16.2 Labels and Nameplates**

The Contractor shall supply and install all labels, ratings, instruction and warning plates necessary for the identification and safe operation of the works.

Nameplates of labels shall be non-hygroscopic material with engraved lettering of a contrasting color or, alternatively in the case of indoor circuit-breakers, starters, etc. of plastic material with suitably colored lettering engraved thereon.

All the above labels and plates shall be securely fixed to items of plant and equipment with stainless steel rivets, plated self-tapping screws or other approved means. The use of adhesives will not be permitted.

The language of labels, plates and notices shall comply with the requirements of the Contract.

Individual plant items and all relevant areas within the contract works where a danger to personnel exists shall be provided with plentiful, prominent and clear warning notices.

These warning notices shall draw attention to the danger or risk with words which attract attention and summarize the type of risk or danger. The notices shall also carry a large symbol which graphically depicts the type of risk.

All equipment within panels and desks shall be individually identified. The identification shall correspond to that used in schematic and wiring diagrams.

Each circuit breaker panel, electrical control panel, relay panel etc., shall have circuit designation label mounted on the front and rear. Corridor type panels shall additionally have circuit designation labels within the panels.

All equipment and apparatus mounted there on shall be clearly labeled in an approved manner. The function of each relay, control switch, indicating lamp, MCB, link etc. shall be separately labeled.

The Contractor shall be responsible for the relocation, or replacement of all labels on existing plant, which became inaccurate as a consequence of the contract works.

## **1.17 Safety and Security**

### **1.17.1 Interlocks**

A complete system of interlocks and safety devices shall be provided so that the following requirements and any other condition necessary for the safe and continuous operation of the plant are provided:

- ☐ Safety of personnel engaged on operational and maintenance work on the plant.
- ☐ Correct sequence of operation of the plant during starting up and shutting down periods. Safety of the plant when operating under normal or emergency conditions.
- ☐ Interlocks shall be preventive, as distinct from corrective in operation.
- ☐

Where plant supplied under this Contract forms the whole or a part of a system for which one or more interlocking schemes are required, the Contractor shall be responsible for all interlocking schemes for the Project Manager's approval. General descriptions of interlocking requirements are given in the specifications but the Contractor shall include for any other interlocks he considers necessary.

### **1.17.2 Locks, Padlocks, and Key Cabinets**

The Contractor shall provide padlocks, locks, chains or other locking devices for the locking of all equipment cubicles, electrical isolating switches, selector switches, valves, etc. to the approval of the Project Manager.

All locking devices and chains shall be manufactured from corrosion resistant material. All mechanisms shall be provided with a cover to minimize entry of water or dust. Locks shall conform to a master keying feature system to be agreed with the Project Manager for groups of equipment.

All locks shall have individual high integrity locks and shall be provided with (two) keys. Each key shall be provided with a label as specified.

The Contractor will supply and fit key cabinets equipped with labeled hooks, each identified with its appropriate key. Every cabinet shall be provided with a nameplate identifying the cabinet with its respective item or items of plant. Sufficient cabinets will be provided to store all keys supplied under this Contract and cater for future extensions.

The Contractor shall provide comprehensive lock and key schedules to readily permit identification with equipment and doors. Such schedules are not required for loose padlocks.

Where modifications are performed to existing sites the Contractor shall provide a system identical to that existing.

## **1.18 Spare Parts**

### **1.18.1 Commissioning Spares**

In addition to the spare parts being provided for the Employer, the Contractor is responsible for ensuring that he has access to a stock of commissioning spares. Spares provided for the Employer are not to be utilized as commissioning spares, without written approval, in which case the Contractor shall immediately replace the contract spare at his own expense.

All commissioning spares are considered as Contractor's equipment.

## **1.19 Consumable Items**

### **1.19.1 Chemicals and other Consumable**

The Contract includes for the provision of all chemicals, resins, and other consumables required for testing, commissioning and setting to work of each section of the works.

Unless otherwise stated, the Contractor shall provide all such chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period of 12 months for each section of the works from the date of the final certificate.

The Contractor shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

## **1.20 Painting and Cleaning**

Immediately following the award of a contract, the Contractor shall submit the names of the proposed paint supplier and applicator together with a quality assurance program for approval. All paints for a contract shall be provided by one manufacturer and preferably shall be manufactured in one country to ensure compatibility

The painting of the plant shall be carried out in accordance with the appropriate schedule. The work is generally covered by the schedules but where particular items are not referred to specifically, they shall be treated in a manner similar to other comparable items as agreed with the Project Manager.

The schedule indicates standards of surface preparation and painting which is intended to give a minimum service life of 10 years in a coastal industrial environment, with need for minor remedial work only during the intervening period.

Steel sections and plate shall be free from surface flaws and laminations prior to blast cleaning and shall not be in worse condition than Pictorial Standard B, Swedish Standard SIS 05 5900.

The Project Manager is prepared to consider alternative paint schemes to meet the requirements of fabrication using modern automated materials handling systems, provided they offer the same standards of surface protection and service life as those intended by the schedules.

All paints shall be applied by brush or spray in accordance with the schedule, except for priming coats for steel floors, galleries and stairways where dipping is permitted.

Where paint is to be applied by spray, the applicator shall demonstrate that the spray technique employed does not produce paint films containing vacuoles.

Where paint coatings are proposed for the protection of surfaces of equipment exposed to corrosive conditions, such as plant items exposed to brines or sea water immersion in liquid, or wet gases, the coatings shall be formulated to be suitably corrosion resistant and shall be high voltage spark tested at works and/or at site prior to commissioning. The test procedure shall be based on the use of a high voltage direct current. The voltage used shall be 75% of the breakdown voltage of the coating. This breakdown voltage shall first be separately determined using test plates coated with the specified coating formulation and thickness. The coating on the test plate shall also be micro-sectioned by the applicator to show that it is free from vacuoles and other defects likely to invalidate the test procedure.

If the defects revealed by the above test procedure do not exceed one per 5 m<sup>2</sup> of coating surface, the coating need not be re-tested after the defects have been repaired. If the defects exceed one per 5 m<sup>2</sup> of coating surface, the repairs shall be resettled after any curing is completed, and this procedure shall be repeated until the defects are less than one per 5 m<sup>2</sup> of coating surface. After repair of these defects, the equipment can be placed in service without further testing.

All coating proposed for the internal protection of domestic water storage tanks and desalination plants shall be certified by an approved independent Authority as suitable for use in potable water installations and shall meet the non-painting requirements of BS 3416.

All plain shed and bright parts shall be coated with grease, oil or other approved rust preventive before dispatch and during erection and this coating shall be cleaned off and the parts polished before being handed over.

Where lapped or butted joints form part of an assembly which is assembled or part assembled prior to final painting, the jointed surfaces shall be cleaned free from all scales, loose rust, dirt and grease and given one brush applied coat of zinc phosphate primer before assembly.

Paint shall not be applied to surfaces which are superficially or structurally damp and condensation must be absent before the application of each coat.

Painting shall not be carried out under adverse weather conditions, such as low temperature (below 4<sup>0</sup>C) or above 90% relative humidity or during rain or fog, or when the surfaces are less than 3<sup>0</sup>C above dew point, except to the approval of the Project Manager or his duly appointed representative.

Priming coats of paint should not be applied until the surfaces have been inspected and preparatory work has been approved by the Project Manager or his duly appointed representative.

No consecutive coats of paint, except in the case of white, should be of the same shade. Thinners shall not be used except with the written agreement of the Project Manager.

On sheltered or unventilated horizontal surfaces on which dew may linger more protection is needed and to achieve this additional top coat of paint shall be applied.

The schedules differentiate between 'Treatment at Maker's Works' and 'Treatment at Site after Completion of Erection' but the locations at which different stages of the treatments are carried out may be modified always providing that each change is specifically agreed to by the Project Manager and the painting is finished at site to the Project Manager's satisfaction.

All paint film thickness quoted are minimum and refer to the dry film condition. All thickness shall be determined by the correct use of approved commercial paint film thickness measuring meters.

The Contractor shall ensure that precautions are taken in packing and crating to avoid damage to the protective treatment applied before shipment, during transport to the site.

Structural bolts shall be galvanized, sherardized or cadmium plated and painted as for adjacent steelwork.

All structural timber that does not require to be painted (timber joists, flooring, etc) shall be treated with two coats exterior grade approved timber preservative.

The requirements of this clause and the schedules shall be interpreted in accordance with the requirements and recommendations of BS 5493 and CP 231, 3012 and the paint manufacturer's special instructions where applicable.

Colour shall be in accordance with BS 1710 and BS 4800 or equivalent material standards.

## **1.21 Galvanized Work**

All galvanizing shall be carried out by the hot dip process (and unless otherwise specified, shall conform in all respects with the relevant IEC specification).

Attention shall be paid to the detail of members, (in accordance with IEC specification). Adequate provision for filling venting and draining shall be made for assemblies fabricated from hollow sections. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel, including cracks, surface laminations, laps and folds shall be removed (in accordance with IEC specification). All drilling cutting, welding, forming and final fabrications of unit members and assemblies shall be completed before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from welding slag, paint, oil, grease and similar contaminants.

The coating shall be as specified in BS 720 or equivalent National standard. Structural steel items shall initially grit blasted to BS 4232, second quality (SA2.5) and the minimum average coating weight on steel sections 5 mm thick and over shall be as specified in the table below:

| <b>THICKNESS OF STEEL<br/>AVERAGE SECTION</b> | <b>THICKNESS OF SIZE<br/>COATING WEIGHT</b> | <b>MINIMUM COATING<br/>g/m<sup>2</sup></b> |
|-----------------------------------------------|---------------------------------------------|--------------------------------------------|
| <b>mm</b>                                     | <b>microns</b>                              |                                            |
| 5                                             | 80 – 90                                     | 600                                        |
| 10                                            | 100 – 120                                   | 750                                        |
| 20                                            | 120 – 150                                   | 900                                        |

With intermediate values on a pro rata basis. On removal from the galvanizing bath the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high strength friction grip bolts shall be roughened before assembly so that the required slip factor (defined in BS 3294. Part BS 4606 part 1 and I) is achieved, care shall be taken to ensure that the roughening is confined to the area of the faying surface.

Bolts, nuts and washers, including general grade high strength friction grip bolts (referred to in BS 3139 and BS 4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to BS 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled

to permit the nuts to be finger turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of a galvanized high strength friction grip bolt after the bolt has been inserted through the steelwork shall be allowed to come into contact with the faying surfaces.

During off-loading and erection, nylon slings shall be used. Galvanized work which is to be stored in works on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (with rust).

Small areas of the galvanized coating damaged in any way shall be brought to the attention of the Project Manager who shall authorize repair by:

Cleaning the area of any weld slug and through wire brushing to give a clean surface.

The application of two coats of zinc rich paint or the application of low melting point zinc alloy repair rod or powder to the damage area, which is heated to 300°C.

After fixing, bolt heads, washers and nuts shall receive two coats zinc rich paint.

## **1.22 Mechanical Items**

All screw threads shall be of the ISO metric form and the diameters and pitch of thread for all bolts studs and nuts shall conform to the ISO Standards as stated in BS 3692 or BS 4190 or equivalent National Standard.

It is recognized that in a number of applications such as instrument, machine components and pipe, other thread forms may be used.

### **1.22.1 Pipe Work**

All piping shall be designed, manufactured and tested in accordance with British Standards or equivalent National Standards approved by the Project Manager. In particular, pipe work should meet the requirements of the following standards or their equivalents. Dimensions shall comply with Table 1 of BS 1600. The minimum wall thickness of carbon steel pipes excluding any allowance for corrosion shall be as shown in British Standards:

| <b>Diameter</b> | <b>Minimum Wall Thickness</b> |
|-----------------|-------------------------------|
| 0-100mm         | Table 2BS1387                 |
| 150-200mm       | 4.87mm                        |
| 250-600mm       | 6.35mm                        |

Drains and air vents shall be provided as required by the physical arrangement of the pipe work and shall be via valves with the drain and vent pipe work led to drain points to the approval of the Project Manager.

Screwed pipe work systems shall be provided with adequate unions to enable valves and fittings to be removed if required with minimum disturbance to the rest of the pipe system.

### **1.22.2 Bolts, Studs, Nuts and Washers**

All bolts and nuts shall conform dimensionally to the requirements of BS 3092 or BS 4190 or equivalent National Standard.

The material of all bolts, studs and nuts for piping systems shall conform to the requirements of BS 4505 or equivalent National Standard.

The threaded portion of any bolt or stud shall not protrude more than 1.5 threads above the surface of its mating nut.

When fitted bolts are used, they shall be adequately marked to ensure correct assembly. Bolts, nuts, studs and washers in contact with sea water or used on pipe work systems containing sea water shall be of the same material as flanges etc.

The use of slotted screws shall be avoided; hexagon socket screws or recessed type heads being preferred.

### **1.23 Electrical Insulation**

Insulating materials shall be suitably finished so as to prevent deterioration of their qualities under the specified working conditions. Account shall be taken of the IEC 60085 and IEC 60505 recommendations.

Ebonite, synthetic resin-bonded laminated material and bituminized asbestos cement-bonded panels shall be of suitable quality selected from the grades or types in the appropriate British, IEC, or approved National Standard.

All cut or machined surfaces and edges of resin-bonded laminated materials shall be cleaned and then sealed with an approved varnish as soon as possible after cutting.

Linseed oil and untreated materials of fiber, leatheroid, presspahn, asbestos or other similar hygroscopic types of materials shall not be used for insulation purposes. Untreated leatheroid and presspahn may be used for mechanical protection of winding insulation.

Wherever practicable, instrument, apparatus and machine coil windings, including wire wound resistors, with the exception of those immersed in oil or compound, shall be thoroughly dried in a vacuum or by other approved means and shall then be insulated with varnish. Varnish with a linseed oil base shall not be used.

No material of a hygroscopic nature shall be used for covering coils. Where inter-leaving between windings in coils is necessary, only the best Manila paper, thoroughly dried, which permits penetration by the insulating varnish or wax, shall be used.

### **1.24 L.V. Circuit Protections**

Fuses are not to be used for protection of circuits below 1000V phase-to-phase, (Low Voltage).

All low voltage and dc circuit protection is to be provided by molded case, or miniature circuit breakers.

Link carriers and bases shall be of an approved manufacture and of such form and material so as to protect persons from shock and burns in normal service and maintenance. Links and fixed contacts shall be shielded to prevent inadvertent contact with live metal whilst the link is being inserted or withdrawn.

The labeling of carriers and bases shall comply with IEC 60269 Identification labels fixed to panels, boards and desks for MCBs and links shall describe their duty, voltage and rating.

#### **1.24.1 Miniature Circuit Breakers**

All miniature circuit breakers (MCBs) shall comply with IEC 60157 and be fitted with over-current releases of both the thermal and instantaneous type. All MCBs supplied on this contract shall be to short circuit category P2 of IEC 60157.



Single, two or three pole breakers may be used where appropriate and a trip of one pole shall cause a complete trip of all associated poles. In addition, the rating given of MCBs supplied shall be confirmed as that appropriate to the enclosure provided.

The Contractor shall ensure satisfactory time and current grading with other associated miniature circuit breakers or MCCBs.

#### **1.24.2 Distribution Boards and Isolators**

Distribution boards shall be provided throughout the plant for local distribution of lighting, small power and air conditioning supplies. The lighting and small power circuits may use a common distribution board.

Distribution boards shall be of 1 kV A.C., 1.2 kV D.C. rating and conform to IEC 60439. All distribution boards shall be of the weatherproof enclosure type and shall be arranged so that the door or cover can be locked in the closed position.

All triple pole and neutral boards shall provide satisfactory cable entry for all cables which could be required for the number of circuit facilities provided and shall have the neutral bar drilled for the full number single phase ways.

Each distribution board supplied from a remote location shall have a load breaking/fault making incoming isolating switch mounted adjacent to or as part of the distribution board. Each distribution board shall have removable top and bottom (undrilled) gland plates.

Each circuit in every distribution board shall be numbered and identified by means of a schedule attached to the interior of the door or cover of the board. The schedule shall be legible and durable to the Project Manager's approval.

Twenty-five percent spare ways shall be provided for future use.

#### **1.25 Electrical Equipment, Instruments and Meters**

All instruments and meters shall be fitted with glasses of low reflectivity and shall not cause pointer deflection due to electro-static charging through friction.

All indicating instruments shall be of the flush mounted pattern with dust and moisture proof cases complying with BS. 2011, Classification 00/50/04, and shall comply with BS. 89 or IEC 60051.

Unless otherwise specified, all indicating instruments shall have 95mm square cases to DIN standard or equivalent circular cases.

Instrument dials in general shall be white with black markings and should preferably be reversible where double scale instruments are specified.

Scales shall be of such material that no peeling or discoloration will take place with age under humid tropical conditions.

The movements of all instruments shall be of the dead-beat type.

Instruments shall be provided with a readily accessible zero

adjustments.

The mounting height of the Centre of all indicating instruments shall not exceed 2000mm.

A.C. ammeters for transformer, feeder or inter connector circuits, and D.C ammeter for all load circuits except motors, shall have linear scales commencing at zero.

A.C and D.C ammeters for motor circuits shall have scales commencing at zero and with a compressed overload portion for reading of the associated minor starting current. D.C. ammeters for the main battery circuit of D.C systems shall have scales with positive and negative ranges, labeled charge and discharge respectively.

Voltmeters for feeders and transformer circuits shall have expanded scales to display the nominal service voltage  $\pm 20\%$ .

Wattmeter for feeders shall have linear positive and negative reading scales to be approved.

Varmeters for all circuits shall have linear positive and negative reading scales to be approved.

Integrating metering shall be provided where indicated on the specification drawings. These meters shall be of the withdraw able flush mounted type and comply with the relevant parts of IEC 60521 and BS 5685, Class 1.0 accuracy and BS 37, Part 9. The meters shall include cyclometer dial type registers.

Approved test terminal blocks of the three-phase type shall be provided for connecting in circuit with each meter a portable testing meter.

If applicable, recording instruments shall be of an approved type, and unless otherwise specified, shall have two chart speeds of 25 mm and 50 mm per hour available for selection by means other than changing connections. They shall be complete with sufficient charts and inks for two years' working.

All instruments, meters, recorders and apparatus shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated switchgear through the primaries of their corresponding instrument transformers.

All instruments, motors and apparatus shall be back connected and the metal cases shall be earthed.

All voltage circuits to instruments shall be protected by a fuse in each unearthed phase of the circuit placed as close as practicable to the main connection.

All power-factor indicators in 3-phase circuits shall have the star point of their current coils brought out to a separate terminal which shall be connected to the star point of the instrument current transformer secondary windings.

All instruments and meters associated with multi-ratio CTs shall be provided with sets of scales etc. appropriate to each CT ratio. It shall be possible to replace the scales of instruments without dismantling the instruments or interfering with any tropicalization finish.

The Contractor shall provide electrical instrument and meter schedules to include, manufacturer, type, designation, current and voltage rating, accuracy class and circuit designation.

All equipment shall be colored "NEMA Standard Grey 70" unless otherwise specified by the Project Manager.

## **1.26 Control and Selector Switches**

Control switches shall be of the three-position type with a spring return action to a central position (and without a locking feature).

Circuit breakers shall have control switches which shall be labeled open/N/close or (O/N/I and arranged to operate clockwise when closing the circuit breakers and anti-clockwise when opening them, and shall be of the pistol grip type.

Control switches of the discrepancy type shall be provided where specified. Such discrepancy control switches shall be arranged in the lines of the mimic diagram on the switchgear panels. Such switches shall include lamps and be of the manually operated pattern, spring loaded such that it is necessary to push and twist the switch past its indicating position for operation. The lamp shall be incorporated in the switch base and shall flash whenever the position of the circuit breaker is at variance with the position indicated by the control switch. Hand dressing of the control switch to the correct position shall cause the lamp to extinguish.

Selector switches shall be of the two or more-position type as required, and have a stay-put action to remain in any selected position which shall be lockable (separate padlocks each with duplicate keys should be provided). Each position of the selector switches shall be suitably labeled to signify their function. The switch handle shall be of the pistol grip type to the approval of the Project Manager.

It shall not be possible at any time to operate any switchgear equipment from more than one location simultaneously, and suitable lockable selector switches shall be provided to meet this requirement.

The contacts of all control and selector switches shall be shrouded to minimize the ingress of dust and accidental contact, and shall be amply rated for voltage and current for the circuits in which they are used.

## **1.27 Auxiliary Switches**

Auxiliary switches shall be to approval and contacts shall have a positive wiping action when closing.

All auxiliary switches, whether in service or not in the first instance, shall be wired up to a terminal board and shall be arranged in the same sequence on similar equipment.

Auxiliary switches mechanically operated by the circuit breakers, contactors, isolators, etc. shall be to approval and contacts mounted in accessible positions clear of the operating mechanism of the circuit breaker, contactor, isolator, etc., and they shall be adequately protected against accidental electrical shock.

Auxiliary switches shall be provided to interrupt the supply of current to the trip coil of each circuit breaker and contactor immediately the breaker or contactor has opened. These auxiliary switches shall make before the main contacts, during a closing operation.

A minimum of four spare auxiliary switches, two normally open, two normally closed shall be provided for each circuit breaker, and contactors and also for isolators.

## **1.28 Alarm Equipment**

Where an alarm system is specified, it shall consist of an initiating device, a display unit and push buttons mounted on the front of the appropriate control panel, together with a continuously rated audible warning device flasher unit and relays. The relays shall wherever possible, be mounted inside the same panel; where the number of alarms to be displayed makes this impracticable, a separate alarm relay cubicle or cubicles will be considered as an alternative.

Where it is necessary to differentiate between the urgency of alarms then various approved alarm tone devices shall be provided in this Contract. In addition, and where specified an alarm beacon to the approval of the Project Manager shall be provided.

The display unit shall consist of a rectangular frame or bezel enclosing the required number of individual facias, each of which shall be preferably approximately 32mm x 25mm in size. Each fascia shall be in the form of a window inscribed with the specified legend, describing the fault condition to be indicated. Lamps shall not illuminate adjacent windows.

At least 3 spare ways shall be provided on each display unit. All unused ways in a display unit shall be fully equipped and the alarm system designed to enable these ways to be utilized at a future date.

Alarm relays shall be of a type to the approval of the Project Manager, arranged to plug into fixed bases, either singly or in groups and have positive means of retaining them securely in the service position, the bases being mounted on racks or frames which shall be hinged to allow them to be swung clear of the sides of the panel or cubicle in which they are installed in order to provide ready access.

The type of wiring used for internal connections between alarm facias and their relays and between relays and terminal blocks, shall generally comply with these requirements with the following exceptions: -

(i) Single-strand wire, not less than 0.85 mm in diameter may be used. Soldered terminations will be acceptable

External connections for alarm circuits will in general be run in multi-core cables having a larger core size than that referred to above. This will necessitate special terminal blocks, if soldered terminations are used, in which case the internal and external terminations of each pair shall be joined by a removable link. Samples of the type of wire and terminal block to be used for alarm connections shall

be submitted for the Project Manager's approval.

### **The operation of the alarm system shall be as follows: -**

When an external alarm indicating contact closes the audible warning shall sound continuously and the appropriate fascia shall be illuminated by a flashing light at a frequency which allows the inscription to be easily read.

An 'Accept' push-button shall be provided on or near the display unit, which when pressed, shall silence the audible signal and cause the fascia to remain illuminated steadily.

The alarm circuit shall be designed to retain the indication after the re-opening of the initiating contact, requiring a separate 'Reset' push button to be pressed before the alarm is cancelled.

A 'Test' push button shall be fitted close to the 'Accept' and 'Reset' buttons, to illuminate all the facias on the associated display unit for as long as the 'Test' button is held depressed.

The operation of the 'Accept' button shall not preclude the receipt of further indications giving more audible alarm and visual indications as the result of the operation of other sets of alarm contacts.

Relays shall not be continuously energized when the alarm system is at rest.

For all alarm indication initiating device a spare set of voltage-free contacts shall be provided (this may be by the use of auxiliary relays) and connected by cable to a suitable, approved marshalling

cubicle. These spare contacts will provide for the transmission of the alarm indication signals to the remote Grid Control Centre.

The Contractor shall be responsible for providing all the alarms required for the safe and efficient operation of the plant. General descriptions of alarms requirements are given in the specification and the Contractor shall include any other alarms that are necessary due to the type of equipment and design of the plant to the Project Manager's approval.

## **1.29 Panels, Desks, Kiosks and Cubicles**

### **1.29.1 General Requirements**

Unless otherwise specified, panels, desks and cubicles, shall be of floor-mounted and free-standing construction and be in accordance with the specified enclosure classification. All control and instrumentation panels shall be identical in appearance and construction.

Panels shall be rigidly constructed from folded sheet steel of adequate thickness to support the equipment mounted thereon, above a channel base frame to provide a toe recess. Alternatively, a separate kicking plate shall be provided.

Overall height, excluding cable boxes, shall not exceed 2.5 m. operating handles and locking devices shall be located within the operating limits of 0.95m and 1.8m above floor level. All panels shall be fitted with padlocks. The minimum height for indicating instruments and meters shall be 1.5m unless otherwise specified.

All panels' desks and cubicles shall be vermin and insect proof. All cable entries to equipment shall be sealed against vermin as soon as possible after installation and connecting-up of the cables to the approval of the Project Manager.

Ventilation shall be provided for natural air circulation. All control equipment shall be designed to operate without forced ventilation.

For outdoor equipment, metal to metal joints shall not be permitted and all external bolts or screws shall be provided with blind taped where a through hole would permit the ingress of moisture. All metal surfaces shall be thoroughly cleaned and particular care taken during painting to ensure that both internally and externally a first class cover and finish is achieved. For harsh environments, all nuts, bolts and washers shall be plated.

Door sealing materials shall be provided suitable for the specified site conditions. Doors shall be fitted with handles and locks. The doors shall be capable of being opened from within the panel without the aid of a key after they have been locked from the outside. Hinges shall be of the life-off type. Seals shall be continuous or with only one joint.

The bottom and/or top of all panels shall be sealed by means of removable gasketed steel gland plates and all necessary glands shall be supplied and fitted within the Contract.

Panels shall be suitably designed to permit future extension wherever appropriate or specified without the need to dismantle the existing panels. Panels shall be "top entry" types with respect to control cabling.

Each panel shall include rear access doors and door-operated interior lamp, and be clearly labeled with the circuit titled at front and rear, with an additional label inside the panel. Panels sections accommodating equipment at voltages higher than 110 V shall be partitioned off and the voltage clearly labeled. Each relay and electronic card within panels shall be identified by labels permanently attached to the panel and adjacent to the equipment concerned. Where instruments are terminated in a plug and socket type connection both the plug and the socket shall have permanently attached identifying labels.

Instrument and control devices shall be easily accessible and capable of being removed from the panels for maintenance purposes.

For suites of panels inter-panel bus wiring shall be routed through apertures in the sides of panels and not via external multi-core cabling between the panels.

All panels, whether individually mounted or forming part of a suit, shall incorporate a common internal copper earthing bar onto which all panel earth connections shall be made. Suitable studs of holes to the Project Manager's approval shall be left at each end of the bar for connection to the main station earthing system.

Earth connection between adjacent panels shall be achieved by extending the bar through the panel sides and not by interconnecting external cabling.

Cubicles and cubicle doors shall be rigidly constructed such that, for example, door mounted emergency trip contacts can be set so that mal-operation will not be possible due to any vibrations or impacts as may reasonably be expected under normal working conditions.

### **1.29.2 Indicating Lamps**

All new indicators shall have a minimum continuous burning guaranteed life of 10,000 hours, at their rated voltage.

The Indicating lamps must be LEDs only and cluster LEDs for important functions subject to approval of the Project Manager.

Indicators shall be easily replaceable from the front of the panel and shall be adequately ventilated. LED indicators shall operate at not less than 20mA and red LED indicators shall be of the high brightness types.

The lamps shall be clear and shall fit into a standard form of lamp holder. The rated lamp voltage should be ten percent in excess of the auxiliary supply voltage, whether AC or DC. Alternatively, low voltage lamps with series resistors will be acceptable, however resistors shall be dimensioned to avoid damage due to heat.

The lamp glasses shall comply with BS 1376 and BS 4099 or equivalent National Standard and shall be in standard colours, red, green, blue, white and amber. The colour shall be in the glass and not an applied coating and the different coloured glasses shall not be interchangeable. Transparent synthetic materials may be used instead of glass, provided such materials have fast colours and are completely suitable for use in tropical climates.

Normally energized indicating lamps, if employed, shall in general be energized from the station LVAC supply.

Lamps and relays incorporated in alarm fascia equipment shall be arranged for normal operation from the station battery, subject to the approval of the Project Manager.

Lamp test facilities shall be provided so that all lamps on one panel can be tested simultaneously by operation of a common push-button. Where alarm facias are specified, all alarm and monitoring indications (apart from circuit-breaker and disconnector position indications) shall be incorporated in the fascia.

Where specified every circuit breaker panel shall be equipped with one red and one green indicator lamp, indicating respectively circuit closed and circuit open and an amber lamp for indicating

'auto-trip'. Where specified in the lines of mimic diagrams, indicating lamps may be of the three-lamp single-aspect type.

All lamps shall be renewable from the front of panels without the use of special tools.

The variety of indicating lamps provided shall be rationalized to reduce maintenance and spares requirements.

### **1.29.3 Anti-Condensation Heaters**

All switchboards, panels, cubicles, motor control Centre and the like shall incorporate electric heaters capable of providing movement of sufficient heated air to avoid condensation. The power supply to the heaters shall be manually switched by a two pole switch with red lamp. All heaters on multi-panel equipment shall be controlled from a single point. The related equipment shall be designed to accept the resulting heat input.

Bus wiring shall be incorporated in switchboards for supplying the heaters.

## **1.30 Panel Wiring and Terminal Boards**

### **1.30.1 General**

All electrical equipment mounted in or on switchgear, panels, kiosks, and desks, etc. shall have readily accessible connections and shall be wired to terminal blocks for the reception of external cabling.

All wiring shall be of adequate cross-sectional area to carry prospective short-circuit currents without risk of damage to conductors, insulation or joints.

All cabling shall be of type CR or CK to BS 6231 unless the design of the plant requires the cabling to withstand more onerous operating conditions in which case cabling shall be suitable for these conditions. The minimum cross section of wire shall be 4 sq.mm for all secondary wiring associated with current transformers of nominal secondary rating of 0.5 A or greater. The size of wiring for circuits other than CT secondary wiring shall be not less than 2.5 sq. mm. Cross-sectional area, save as permitted in the specification.

The minimum strand diameter of copper or tinned copper flexible conductors shall be 0.20 mm for flexible and the minimum cross-sectional area shall be 0.5 sq. mm for all cables. For wiring within panels on circuits not directly associated with circuit breaker protection and control, and having a continuous or intermittent, load current of less than 1 amp, the use of smaller line down to 0.25 sq. mm will be permitted subject to Project Manager's Approval.

Where an overall screen is used, this shall be metallic screen or low resistance tape, with drain wire as above.

Wiring shall be supported using an insulated system which allows easy access for fault finding and facilitates the rapid installation of additional cables.

Small wiring passing between compartments which may be separated for transport shall be taken in terminal blocks mounted near the top of each compartment, separately from those for external cable connections.

Both ends of every wire shall be fitted with ferrules of insulating material complying with BS 3858 or equivalent National Standard and engraved in black. The identification numbering system used for the ferrules shall be to the approval of the Project Manager.

Where new equipment must interface with existing equipment double ferruling shall be employed if the two-numbering system are not compatible.

Connections to apparatus mounted on doors, or between points subject to relative movement, shall be made in cable type CK to BS 6231, arranged so that they are subjected to torsion rather than bending.

### **1.30.2 Identification of Cable Cores**

Where a wire or multi-core cable passes from one piece of equipment to another, e.g. from a circuit breaker to a remote control panel, the Contractor shall ensure that the identity of the wire is apparent at both ends and intermediate marshalling points by the use of ferrules, which shall permit identification of the cable in accordance with the schematic diagrams. The ferruling system to be adopted shall be a composite marking method to IEC 391 and BS 3858 as appropriate, giving functional information on the purpose of the individual conductor plus markings at both-ends.

Should the Contractor's normal practice be at variance with the requirements of this clause he may submit details of the scheme proposed for consideration by the Project Manager. The Project Manager is not obliged to accept the Contractor's proposal.

Each core of multi-pair wiring shall be identified by color and terminal block identification together with an identification tracer per bundle.

Permanent identification of all terminals, wires and terminal blocks shall be provided. Each individual terminal block shall have independent terminals for incoming and outgoing cabling.

### **1.30.3 Terminals and Terminal Boards**

Terminal Assemblies shall be of the unit form suitable for mounting on a standard assembly rail, to give the required number of ways. The units shall be spring retained on the assembly rail. Each individual terminal block shall have independent terminals and outgoing cabling.

End barriers or shields shall be provided for open sided patterns.

It shall be possible to replace any unit in an assembly without dismantling adjacent units. Molding shall be mechanically robust and withstand the maximum possible operating temperatures and torque which may be applied to terminal screw. All live parts shall be recessed in the molding to prevent accidental contact.

Terminals shall be of the screw clamp type for lower current rating which compress the conductor or termination between two plates by means of a captive terminal screw. Contact pressure of screw clamp terminations shall be independent of each other. For higher current ratings bolted type terminals are permitted. Current carrying parts shall be non-ferrous and plated.

All terminals for "incoming" cabling shall have testing facilities, which permit the examination of the state of the circuit without disconnecting the associated cabling. Terminal blocks for current transformer secondary shall be fitted with shorting/disconnect facilities.

Terminal blocks for voltage transformers secondaries shall be isolatable.

Terminal blocks in telemetry marshalling cubicles shall be isolatable. The means of isolation shall be fixed and give visual identification of the status of the terminal.

Not more than 1 wire shall be connected to each terminal and cross-connection facilities shall be provided where numerous cores are to be connected together.



Each terminal block, and every individual terminal shall be identified. The terminal identification number shall be included on associated schematic and wiring diagrams.

The mounting rail may only be used to provide an earth connection, when firmly bonded to the earth bar and to be approved by the Project Manager.

The Contractor shall submit samples of the terminal blocks/mounting rail assemblies together with details of his proposed cabling/termination system to the Project Manager for approval.

Adjacent terminals to which wires of different voltage, polarity or phase are connected shall be separated by a protruding insulating barrier; this requirement also applies to terminals carrying wires of the same voltage but originating from different sources.

Wires shall be grounded on the terminal boards according to their functions. Terminal blocks for connections exceeding 110V shall be fitted with insulting covers.

Terminal blocks shall be mounted not less than 150 mm from the gland plates, and spaced not less than 100 mm apart, on the side of the enclosure.

Sufficient terminals shall be provided to permit all cores on multicore cables to be terminated. Terminals for spare cores shall be numbered and be located at such position as will provide the maximum length of spare core. At least 10% spare terminals shall be provided in all cases.

The tails of multi-core cables shall be bound and routed so that each tail may be traced without difficulty to its associated cable. All spare cores shall be made off to terminals.

When two lengths of screened cable are to be connected at a terminal block (i.e., junction box) a separate terminal shall be provided to maintain screen continuity.

Should the terminal block manufacturer recommend that specific types of terminal tools are used (eg parallel sided screw/drivers) the Contractor shall provide three sets of these at each sub-station site. In addition, the Contractor shall provide 8 numbers, test leads of minimum 1500 mm length which can be inserted into the test terminals of the terminal blocks, at each sub-station. The test leads shall be capable of being 'jumpered' together for multi-instrument use.

The use of pre-formed factory tested cable connections to field mounted marshalling boxes shall be to the Project Manager's approval.

### **1.31 Cable Boxes and Glands**

Electrical equipment supplied under this contract shall be fitted with all necessary cable boxes and glands which shall be complete with all required fittings. Boxes shall be of adequate proportions to accommodate all cable fittings, including stress cones or other means of cable insulation grading, and designed in such a manner that they can be opened for inspection where appropriate without disturbing the gland plate of incoming cable.

Glands for termination of cables to outdoor equipment or indoor areas liable to water spray, hosing or flooding shall incorporate provision for sealing against ingress of moisture or dust, and shall comply with the requirements of BS 6121 for sealing.

Removable gasketed steel gland plates shall be provided for multi-core cables and shall be supported from the sides of the enclosures, as near to the floor or roof as possible while allowing adequate space both above and below the plate for manipulation of the cable and gland. Gland plates for marshalling boxes shall be in the form of removable gasketed steel plate, forming part of the underside of the box.

The terminals for 3 phase cables shall be clearly marked with the phase colors (approved designations) to enable the cables to be terminated in the correct sequence.

Filling and venting plugs where required, shall be positioned so as to avoid the possibility of air being trapped internally and adequate arrangements shall be made for expansion of compound etc. There shall be no possibility of oil entering the cable box from an associated oil filled compartment. Cable sealing ends shall be arranged to project at least 25mm above the gland plate to avoid moisture collecting in the crutch.

Any chamber which is to be compound filled shall be clean and dry and at such a temperature before filling that the compound does not solidify during the filling process. Filling orifices shall be sufficiently large to permit easy and rapid filling.

All cable boxes shall be designed to withstand the high voltage D.C. cable tests prescribed in BS 6346, BS 6480 and IEC 60055 as appropriate.

If applicable, cable boxes for paper-insulated cables shall be complete with universal tapered brass glands (insulated from the box in an approved manner and including an island layer for testing purposes.

Even single core cables are used, particularly for currents in excess of 500 A, adequate steps must be taken to minimize the effects of eddy currents in the gland and bushing-mounted plate.

Cable glands for extruded solid dielectric insulated cables (PVC, EPR, and XLPE) shall be of the compression type and as specified in BS 6121.

Approved glands shall be used on MICC cables

Glands for armored or screened cables above 240 sq. mm shall be provided with an integral heavy duty earthing lug capable of carrying the full earth fault current for a period not less than 1 second without deterioration.

Cable lugs and terminations for the receipt of all power control and instrumentation cable cores shall be provided.

Cable boxes for the termination of elastomeric cables up in 33 kV nominal service voltage shall be designed and dimensioned to provide adequate insulation in air for cables. Clearance and creepage distances shall be adequate to withstand the specified alternating current voltages and impulse voltages for service under the prevailing site conditions. The performance is to be met without the use of insulating 'boots' shrouds or any other material fitted over or between the cable terminations apart from permanently fitted barriers forming part of the switchgear or cable box.

Means shall be provided for preventing accumulation of dirt, dust, moisture, vermin or insects such as to maintain the anticipated life of the equipment. The Contractor shall ascertain the means by which elastomeric cables are to be terminated and shall provide such information or instructions as necessary to any other contractor or sub-contractor to ensure compliance with this clause.

The cable crutch within a cable box or equipment panel shall be protected by the use of a heat-shrink plastic 'udder' plates over the conductors and crutch.

### **1.32 Joints and Gaskets**

All joint faces are to be flat and parallel to the approval of the Project Manager and arranged to prevent the ingress of water or leakage of oil with a minimum of gasket surface exposed to the action of oil or air.

Oil-resisting synthetic rubber gaskets are not permissible, unless the degree of compression is accurately controlled. For gaskets of cork or similar, oil resisting synthetic rubber may be used as a bonding medium. No joints are allowed in gaskets.

### **1.33 Junction, Termination Marshalling Boxes, Operating Cubicles etc.**

All junctions, termination and marshalling boxes shall be of substantial sheet steel construction, having enclosure classification in accordance with the specification and fitted with external fixing lugs and finished in accordance with this Specification for cleaning, painting and finishing.

The boxes shall allow ample room for wiring, with particular regard to the deployment of wires from the point of entry.

Outdoor boxes shall have internal anti-condensation heaters and stay bars fitted to doors. Indoor boxes shall be designed such that any condensed water cannot affect the insulation of the terminal boards or cables. No cables shall be terminated into the top of outdoor boxes unless specifically approved by the Project Manager.

Each box shall be complete with suitably inscribed identification labels.

Any outdoor boxes, cubicles etc. containing instruments or meters shall have glazing suitable to permit the visual examination of these.

Covers shall be arranged for padlocking and padlocks with keys shall be supplied. Cast iron boxes shall have bolted lids requiring the use of special keys or spanners for removal.

All boxes shall be provided with adequate earthing bars and terminals.

Notwithstanding information supplied by the Project Manager, the Contractor shall, as each box is completed or at intervals as requested by the Project Manager, supply to the Project Manager copies of accurate termination or destination charts showing the as-fitted arrangement of cables and cores in each box. The Contractor shall, following the Project Manager's approval, fit one plastic laminated copy of the appropriate chart to the interior of each box.

### **1.34 Conduit and Accessories**

Conduit, accessories and trunking installation shall comply with the latest issue of the Institution of Electrical Engineers Regulations for the Electrical Equipment of Buildings, unless otherwise approved by the Project Manager. In addition, installation shall also comply with all local electricity regulations.

Unless otherwise approved, all conduit and conduit fittings shall be galvanized, of heavy gauge steel, screwed, solid drawn or weld type complying with IEC 60423 and IEC 60614.

No conduit smaller than 19 mm outside diameter shall be used.

Standard circular boxes or machined face heavy-duty steel adaptable boxes with machined heavy type lids shall be used throughout. For outdoor mounting all boxes shall be galvanized, weatherproof and fitted with external fixing lugs.

Conduit terminations shall be fitted with brass bushes.

The use of running threads, solid elbows and solid tees will not be permitted.

Conduit ends shall be carefully reamed to remove burrs. Draw-in boxes shall be provided at intervals not exceeding 10m in straight-through runs.

Conduit runs shall be in either the vertical or horizontal direction unless otherwise approved and shall be arranged to minimize accumulation of moisture. Provision for drainage shall be made at the lowest points of each run.

Conduits shall be supported on heavy galvanized spacer saddles so as to stand off at least 6 mm from the fixing surface.

Provision shall be made for the support of internal conductors in instances where the length of the vertical run exceeds 5m.

All conduits run in any circuit are to be completed before any cables are pulled in. Flexible metallic conduit shall be used where relative movement is required between the conduit and connected apparatus, and a separate copper connection provided to maintain earth continuity.

The maximum number of cables in any conduit shall be in accordance with the latest issue of the IEE Regulations for the Electrical Equipment of Buildings.

#### **1.34.1 Trunking**

Steel trunking etc. may be used for running numbers of insulated cables or wires in certain positions to the approval of the Project Manager. The trunking thickness shall not be less than 1.2 mm.

### **1.35 Push-Buttons and Separately Mounted Push-Button Stations**

Push-buttons shall be shrouded or well recessed in their housings in such a way as to minimize the risk of inadvertent operation. The colour of push-buttons shall be black unless otherwise required by the Project Manager.

Push-button stations supplied as loose equipment shall be of the metal clad weatherproof type suitable for wall or bracket mounting. Each push-button station shall be clearly labeled showing the duty or drive to which it is applicable.

### **1.36 Drawings, Diagrams and Calculations**

#### **1.36.1 General**

The term "drawing" shall also include diagrams, schedules, performance curves, and calculations etc., required for the comprehensive design of the works. The Contractor shall be responsible for the provision of all drawings required for the various stages of the contract. All drawings, apart from workshop drawings, shall be submitted to the Project Manager for his recommendation and final approval by the concerned committee of BREB, in accordance with an approved program. The Contractor shall ensure that drawings are submitted for approval in good time such that they may be approved within the specified period prior to the manufacture or construction commencing. Further adequate time must be allowed by the Contractor to permit any comments made by the Project Manager to be incorporated. Any works performed prior to approval of drawings by the concerned committee of BREB will be entirely at the Contractor's own risk including any delays that may result from modifications being found to be necessary by the Project Manager.

The Contractor shall be fully responsible for obtaining any drawing or data of existing plant and installations that he requires in order to carry out the works, and shall also be responsible for verifying that any drawings of existing plant and installations are accurate. The Contractor shall provide suitable drafting and other staff on site that he requires investigating and producing any drawings that he requires of existing equipment and installations in order to carry out the works. Any cost associated with these requirements is deemed to be included in the contract price.

Where existing installations have been modified or extended the Contractor shall provide complete new sets of drawings. In this respect the Contractor shall provide drawings detailing both the existing and new works and shall not limit the scope of the drawings to the new works only.

5 (Five) sets of As-built drawings together with operation and maintenance manual of the equipment installed shall be submitted.

### **1.36.2 Format**

Drawings are to be submitted for approval on paper prints, folded to A4 size with the project title block and drawing numbers fully visible.

All drawings are to be submitted on "A" series paper to ISO/5457. The maximum size of drawings shall be A1 except for site survey and layout drawings which may be submitted as A0 size sheets, if necessary, to accommodate details on a scale of 1:100. Single line diagrams and schematic drawings shall preferably be on a maximum sheet size of A2. All dimensional drawings shall be to the following scales and fully detailed. 1:1, 1:2, 1:5, 1:10 and factors of 10 thereof.

Drawings symbols shall be in accordance with IEC 60117.

All drawings are to be submitted in Auto Cad format in CDR Disks.

Drawing titles shall clearly identify the specific function of the drawings and where appropriate the name of the site(s) to which the drawing applies.

### **1.36.3 Drawing Numbering and Revisions**

The Contractor shall be responsible for adding the Employer's drawing numbers to all drawings prior to submittal. Following award of the contract, the Project Manager and the Contractor will review the numbering system, familiarize each other with requirements, and agree on the numbering system to be applied.

Comprehensive cross-references are to be included on drawings and the Contractor shall include the Employer's drawing numbers in the cross-references.

At each and every issue of a drawing the revision shall be raised, and details given in revision boxes on the drawings. Comprehensive details of revisions are to be given and phrases such as "REVISED", "UPDATED", "MODIFIED" or similar are not acceptable.

Reference to any drawing in communications shall include the Employer's drawing number.

## **1.37 Operating and Maintenance Manuals**

### **1.37.1 General**

The Contractor shall be responsible for compiling operation and maintenance (O&M) manuals for each section of the works and all equipment used.

Drafts of the manuals are to be submitted to the Project Manager at least six weeks prior to the commencement of pre-energization commissioning checks on Site. Following examination, the Project Manager will forward copies of his comments to the Contractor to action prior to issuing Final O&M manuals. Final O&M manuals are to be available on site prior to the issue of the Taking over Certificate.

Handling, installation, storage and transit instructions, in accordance with BS 4884 part 1, which shall form part of the manuals, are to be available on site prior to the arrival of the Plant.

In addition to the compiled manuals, the Contractor shall submit copies of brochures and other explanatory literature with drawings of the plant, which will assist the Project Manager in approval of the drawings.

### **1.37.2 Contents**

Operation and Maintenance manuals shall be prepared for the equipment supplied for the substation. The content and presentation of the manuals shall conform in full with BS 4884 parts 1 and 2.

The O&M manuals are also to contain a complete drawing list appropriate to the individual section of the works. The drawing list shall include the Project Manager's drawing numbers.

Maintenance instructions for all plant shall cover preventive and corrective maintenance procedures. For electronic or solid-state control, protection equipment etc. details shall be provided to enable individual circuit cards to be checked for correct operation and faults to be traced, and repaired.

The Contractor shall provide proformas of the required maintenance record sheets for all plant, which shall include cross-reference to the appropriate section of the O&M manuals which detail how to perform the tasks required. Any other record sheets suitable for the monitoring of the plant shall also be designed and provided.

### **1.37.3 Binders, Presentation**

The information will be provided on A4 pages, with diagrams on throw-clear pages where required to enable the text and diagrams to be refereed to simultaneously.

The front cover and spine of the manuals shall give the following

information: Project Title  
Employer's name  
Contract number  
Identification of the Section of the Works  
Volume number and total number of volumes applicable (e.g., volume 3 of 5 volumes)  
Contractor's company logo and name

The above shall also be provided on a flysheet inside the front cover of each volume. Draft O&M manuals may be presented in unprinted covers.

Four copies of draft O&M manuals are to be provided to the Project Manager; following approval 8 copies are to be provided to the Project Manager or his site Representative for each section of the works.

### **1.38 Site Storage Facilities**

The Contractor shall provide lockable cabinets in each of the individual substations, which are to contain the following:

- (a) One set of paper prints of the complete record of drawings for the section of the work. These shall be arranged in a logical sequence in accordance with the drawing list contained in the O&M manuals. Record drawings are to be grouped into labeled pockets or binders to minimize disturbance in locating specific drawings. As-built drawings are to be stored in these locations prior to the issue of record drawings.
- (b) Two complete sets of O&M manuals
- (c) Volumes of factory and site test reports/certificates
- (d) Copies of maintenance log sheets, record sheets etc.
- (e) Space for stationery and operators' log books

These cabinets shall match other furnishings being provided in the substation and the location as such items is to be included in the design of the substation layout.

### **1.39 Switchyard Cable Ducts and Conduits**

A system of UPVC conduits (equipment to duct) and precast concrete ducts shall be used for control and LV cabling between switchyard equipment and the control building. Entry to the control/protection panels in the building shall be via the top of the panels and a suitable sealing arrangement.

HV cabling between the transformers and switchgear panels shall be installed in concrete ducts in the switchyard and within the building. HV Cabling between the control building and the feeder termination poles shall be direct buried outside the building.

## 2.0 Particular Technical Requirements for Substation Electrical Equipment

### Specification of 10/14 MVA & 20/28 MVA OLTC power Transformer with Auxiliary Transformer & Lightning Arrester

#### PART-1:

#### GENERAL

#### SCOPE

The transformers shall be suitable for continuous operation on a three-phase 50 Hz high voltage transmission system as specified in the Schedule of Requirements.

The transformers shall be of the three phase oil immersed type and designed with particular attention to the suppression of harmonic especially the third and fifth harmonics and to minimize the detrimental effects resulting there from. All transformers shall be suitable for outdoor installation on concrete bases and shall be designed to operate satisfactorily in parallel with each other. The transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of

The cooling for the transformers shall be ONAN/ONAF as specified.

#### REFERENCES

##### British Standards

|         |  |                                                                                                                            |
|---------|--|----------------------------------------------------------------------------------------------------------------------------|
| BS 61   |  | Specification for threads for light gauge copper tubes and fittings                                                        |
| BS 3600 |  | Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes |
| BS 4504 |  | Circular flanges for pipes, valves and fittings (PN designated)                                                            |
| BS 6121 |  | Mechanical cable glands                                                                                                    |
| BS 6346 |  | Specification for PVC insulated cables for electricity supply                                                              |
| BS 6435 |  | Specification for unfilled enclosures for the dry termination of HV cables for transformers and reactors                   |
| BS 7354 |  | Code of practice for design of HV open terminal stations                                                                   |
| BS 7613 |  | Specification for hot rolled quenched and tempered weldable plates                                                         |

##### BS European Standards

BS EN 10029 Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3mm thick and above

##### IEC Standards

|         |  |                                                                                       |
|---------|--|---------------------------------------------------------------------------------------|
| IEC 76  |  | Power transformers                                                                    |
| IEC 137 |  | Insulated bushings for ac voltages above 1000V                                        |
| IEC 186 |  | Voltage transformers                                                                  |
| IEC 214 |  | On load tap changers                                                                  |
| IEC 228 |  | Conductors of insulated cables                                                        |
| IEC 233 |  | Tests on hollow insulators for use in electrical equipment                            |
| IEC 296 |  | Specification for unused mineral insulating oils for transformers and switchgear      |
| IEC 354 |  | Loading guide for oil immersed power transformers                                     |
| IEC 422 |  | Supervision and maintenance guide for mineral insulating oils in electrical equipment |
| IEC 529 |  | Degrees of protection provided by enclosures                                          |
| IEC 551 |  | Determination of transformer and reactor sound levels                                 |



## CLIMATE DATA

Main climate data that must be taken into account for the goods will be the followings: Climate : Tropical, intense  
sunshine, heavy rain  
Maximum Temperature : 45°C  
Minimum Temperature : 03°C  
Average daily Temperature : 35°C  
**Average isokeraunic level** : 80 days/ year  
Relative humidity : 50-100%  
Average annual rain fall : 3454mm  
Maximum wind velocity : 200 km/hour  
Altitude : 300 meters above  
Sea level Atmospherically, Mechanical and Chemical  
impurities: Moderately polluted

The information is given solely as a guide for Tender and no responsibility for its, Accuracy will be accepted not will any claim based on the above be entertained.

Transformer supplied under this contract will be installed in tropical locations that can be considered hostile to its proper operation. Particular problems that shall receive special consideration relate to operation in a humid environment and presence of insects and vermin.

## SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics:

- Frequency : 50Hz
- Nominal system voltages : 33kV 11kV  
400/230V
- Maximum system voltages : 33kV System 36kV 11kV System 12kV LV System 440V
- Minimum LV voltage : 360V
- Nominal short circuit levels : 33kV System 31.5 kA  
11kV System 31.5 kA
- Insulation levels:  
1.2/50 ms impulse withstand  
(positive and negative polarity) : 33kV System 170kV  
11kV System 75kV
- Power frequency one minute  
withstand (wet and dry) : 33kV System 70kV 11kV System 28kV  
LV System 3kV
- Neutral earthing arrangements : 33kV System solidly earthed  
11kV System solidly earthed LV System solidly earthed

## INSPECTION AND TESTING

During pre-delivery/ pre-shipment inspection; BREB's inspection team will witness the following test of not less than 10% of total quantity ready for delivery on random sampling basis (sample selected by the inspection team) during factory test in manufacturer's factory premises:

1. Measurement of turn ration test;
2. Vector group test (check of phase displacement)
3. Measurement of winding resistance;
4. Measurement of no load loss & no-load current;
5. Measurement of impedance voltage & load loss;
6. Dielectric withstands test;
7. Transformer oil test;
8. Temperature rise test.
9. Impulse test.

Besides BREB's inspection team will perform some physical test of at least 10 (ten) % transformer of on random sampling basis during factory test:

1. Transformer tank sheet thickness (top bottom & side);
2. Hot dip galvanization test as per standard BS-729 of all bolts & nuts connected with transformer tank, conservator, radiator etc;
3. Dimension of bolted type bimetallic connector for H.T. and L.T. bushing;
4. Dimension of tanks;
5. Checking of creep age distance of HT/LT bushings.
6. Others visible parts as per approval drawing.

As and when the Purchaser is satisfied that any materials/equipment shall have passed the relevant tests, the Purchaser shall notify the contractor in writing to that effect.

Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the items or complete batch if necessary. In that case the Supplier shall replace the goods make good them without any financial involvement to the Purchaser. The inspection and testing shall be carried out again and all cost thereof shall be borne by the Supplier.

Nothing in this clause shall in any way release the supplier from any warranty or other obligations under the contract.

### **Type Tests:**

The following shall be regarded as type tests. Supplier shall submit all Type test reports from internationally recognized independent testing laboratory along with bid proposal.

### **Type Tests (for Transformer):**

- (a) Test of temperature rise.
- (b) Short circuit test.
- (c) Dielectric test: (Induced over voltage test, Lightning Impulse voltage withstand test, Power frequency voltage withstand test)

Temperature Rise, Short Circuit and Dielectric test (Induced over voltage test, Lightning Impulse voltage withstand test, Power frequency voltage withstand test) on one Transformer of each type and size (i.e. same KVA, KV, AMPS, Frequency, Impedance, Weight of the Core, Oil etc. with tolerance  $\pm 5\%$ ) of Transformer. These all type tests shall be done on same Transformer.

### **HT Bushing type test:**

- Dry or wet power-frequency voltage withstand test;
- Dry lightning impulse voltage withstand test;
- Temperature rise test ;
- Verification of thermal short-time current withstand;
- Cantilever load withstand test;
- Verification of dimensions.

### **Special Tests:**

- a) Noise level measurement, in accordance with IEC Publication 551 using a precision sound level meter conforming to IEC Publication 651. In addition the test shall be repeated with narrow band filters for the harmonic frequencies from 100Hz. up to 350 Hz.
- b) Magnetic balance test.
- c) Dissolve gas test (for transformer oil).
- d) Harmonics measurement test.

### **Routine Tests**

The following shall be regarded as routine tests and shall be carried out on each transformer.

- (a) Measurement of winding resistance at principal tap and two extreme taps.
- (b) Voltage-ratio measurement and check of vector group.

- (c) Measurement of the impedance voltage at principal tap and two extreme taps.
- (d) Measurement of the load loss.
- (e) Measurement of no-load loss and no-load current, including measurement of harmonics.
- (f) Applied voltage test to all auxiliary circuits.
- (g) Tests on on-load tap-changer (fully assembled on transformer).
- (h) Induced over-voltage withstand test. The voltage applied shall be the relevant power frequency voltage specified in the clause on Insulation Levels.
- (i) Separate source voltage withstand test. The applied voltage shall be the relevant power frequency voltage specified in the clause on Insulation Levels.
- (j) Polarization index test (1 minute and 10 minute). Index shall be not less than 1.3.
- (i) Dielectric withstands test;
- (j) Transformer oil test;

## **Routine Test Sequence**

The sequence of tests shall be:

- (a) Winding resistance measurement, voltage ratio measurement and vector group check
- (b) Separate source voltage withstand test, induced over-voltage withstand test, **impulse test**.
- (c) Impedance voltage and loss measurements.
- (d) Tap changer test.
- (e) Tests on auxiliary circuits.

The following tests on site will be carried out under a different contract after plant is fully assembled:

- (a) Ratio and vector group checks.
- (b) Insulation resistance (HV-LV, HV-E, LV-E).
- (c) Oil tests.
- (d) Other necessary pre-commissioning tests.

The Supplier will be held responsible for any discrepancy or defect discovered during these tests and shall rectify immediately on receipt of notification at no cost to the Purchaser. The Supplier may at his own discretion witness site testing of transformers.

## **PACKING AND SHIPPING**

### **Packing**

The equipment and any supporting structures are to be transported adequately sealed against water ingress. All accessories and spares shall be packed and securely clamped against movement in robust, wooden, non returnable packing cases to ensure safe transit in rough terrain, cross country road conditions and in heavy rains from the manufacturer's works to the work sites.

- individual serial number;
- purchaser's name;
- contract number;
- destination;
- a colour coded marking to indicate destination;
- supplier's name;
- name and address of supplier;
- description and numbers of contents;
- manufacturer's name
- country of origin;
- case measurements;
- gross and net weights in kilograms; and
- all necessary slinging and stacking instructions.

Each crate or container shall be marked clearly on the outside of the case to show TOP and BOTTOM positions with appropriate signs to indicate where the mass is bearing and the correct positions for slings. All component parts which are separately transported shall have permanent identification marks to facilitate correct matching and assembly at site. Welded parts shall be marked before welding. Six copies of each packing list shall be sent to the Purchaser prior to dispatching the equipment.

## **Shipping**

The Supplier shall be responsible for the shipping of all plant and equipment supplied from abroad to the ports of entry and for the transport of all goods to the various specified destinations including customs clearance, off loading, warehousing and insurance.

The Supplier shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Supplier shall also be responsible for verifying the access facilities specified.

The Supplier shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Supplier shall immediately report to the Purchaser any claims made against the Supplier arising out of alleged damage to a highway or bridge.

All transport accessories, such as riding lugs, jacking pads or blanking off plates shall become the property of the Purchaser. All items of equipment shall be securely clamped against movement to ensure safe transit from the manufacturer's facilities to the specified destinations.

The Supplier shall advise the storage requirements for any plant and equipment that may be delivered to the Purchaser's stores. The Supplier shall be required to accept responsibility for the advice given in so far as these arrangements may have a bearing on the behavior of the equipment in subsequent service.

## **Hazardous substances**

The Supplier shall submit safety data sheets for all hazardous substances used with the equipment. The Supplier shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. No oil shall be supplied or used at any stage of manufacture or test without a certificate acceptable to the Purchaser that it has a PCB content zero. The Supplier shall accept responsibility for the disposal of such hazardous substances, should any be found.

The Supplier shall also be responsible for any injuries resulting from hazardous substances due to non compliance with these requirements.

## **SUBMITTALS**

### **Submittals required with the bid**

The following shall be required with each copy of the bid :

- completed technical data schedule;
- descriptive literature giving full technical details with calculation of heat dissipation, radiator arrangement, no-load loss with considering flux density of equipment offered;
- outline dimension drawing for each major component, general arrangement drawing showing component layout and general schematic diagrams;
- type test certificates, where available, and sample routine test reports;
- list of recommended spare parts and consumable items for five years of operation with prices and spare parts catalogue with price list for future requirements.

### **Submittals required after**

#### **contract award Program**

Five copies of the program for production and testing.

### **Technical Particulars**

Within 30 days of contract award five bound folders with records of the technical particulars relating to the equipment. Each folder shall contain the following information:

- general description of the equipment and all components, including brochures;
- technical data schedule, with approved revisions;
- calculations to substantiate choice of electrical, structural, mechanical component size/ratings;

- detailed dimension drawing for all components, general arrangement drawing showing detailed component layout and detailed schematic and wiring drawings for all components;
- detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer;
- detailed installation and commissioning instructions; at the final hold point for Purchaser approval prior to delivery of the equipment the following shall be submitted;
- inspection and test reports carried out in the manufacturer's works;
- operation and maintenance instructions as well as trouble shooting chart

## **Operation and Maintenance instructions**

The copy of installation and commissioning instructions and of the operation and maintenance instructions and troubleshooting charts shall be supplied with each transformer.

## **Drawings**

Within 30 days of contract commencement the Supplier shall submit, for approval by the Purchaser, a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a program of drawing submission, for approval by the Purchaser that ensures that all drawings and calculations are submitted within the period specified above. All detail drawings submitted for approval shall be to scale not less than 1:20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings. All documents and drawings shall be submitted in accordance with the provisions of this specification and shall become the property of the Purchaser. All drawings and calculations, submitted to the Purchaser, shall be on international standard size paper, either A0, A1, A2, A3 or A4. All such drawings and calculations shall be provided with a contract title block, which shall include the name of the Purchaser and Consultants and shall be assigned a unique project drawing number; the contract title block and project numbering system shall be agreed with the Purchaser. Script sizes and thickness of scripts and lines be selected so that if reduced by two stages the alphanumeric characters and lines are still perfectly legible so as to facilitate microfilming. For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

## **SHIPMENT AND DRYING OUT**

### **Shipment**

Each transformer, when prepared for shipment, shall be fitted with a shock indicator or recorder which shall remain in situ until the transformer is delivered to Site. In the event that the transformer is found to have been subjected to excessive shock in transit, such examination as is necessary shall be made in the presence of the Engineer.

Where practicable, transformers shall be shipped with oil filling to cover core and windings but, when shipped under pressure of gas, shall be fitted for the duration of delivery to Site and for such time thereafter as is necessary, with a gauge and gas cylinder adequate to maintain internal pressure above atmospheric.

All earthing transformers shall be shipped full of oil.

### **Drying Out**

All transformers shall be dried out by an approved method at the manufacturer's works and so arranged that they might be put into service without further drying out on Site.

Clear instructions shall be included in the Maintenance Instructions regarding any special precautionary measures (e.g. strutting of tap changer barriers or tank cover) which must be taken before the specified vacuum treatment can be carried out. Any special equipment necessary to enable the transformer to withstand the treatment shall be provided with each transformer.

## **APPROVAL PROCEDURE**

The Supplier shall submit all drawings, documents and type test reports for approval in sufficient time to permit modifications to be made if such are deemed necessary and resubmit them for approval without delaying the initial deliveries or completion of the contract work. The Purchaser's representative shall endeavor to return them within a period of four weeks from the date of receipt. Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. The Purchaser reserves the right to request any further additional information that may be considered necessary in order to fully

review the drawings. If the Purchaser is satisfied with the drawing, one copy will be turned to the Supplier marked with "Approved" stamp. If the Purchaser is not totally satisfied with the drawing, then "Approved Subject to Comment" status will be given to it and a comment sheet will be sent to the Supplier. If the drawing submitted does not comply with the requirements of the specification then it will be given "Not Approved" status and a comment sheet will be sent to the Supplier. In both these cases the Supplier will have to modify the drawing, update the revision column and resubmit for final Approval. Following approval, twenty copies of the final drawings will be required by the Purchaser within the time allocated for design and drawing approval.

Any drawing or document submitted for information only should be indicated as such by the Supplier. Drawings and documents submitted for information only will not be returned to the Supplier unless the Purchaser considers that such drawing needs to be approved, in which case they will be returned suitably stamped with comments.

The Supplier shall be responsible for any discrepancies or errors in or omissions from the drawings, whether such drawings have been approved or not by the Purchaser. Approval given by the Purchaser to any drawing shall not relieve the Supplier from his liability to complete contract works in accordance with this specification and the condition of contract nor exonerate him from any of his guarantees.

If the Supplier needs approval of any drawing within a period of less than four weeks in order to avoid delay in the completion of supply, he shall advise the Purchaser when submitting the drawings and provide an explanation of the document's late submission. The Purchaser will endeavor to comply with the Contractors timescale, but this cannot be guaranteed.

## **SURFACE TREATMENT**

A full description of the corrosion prevention system proposed by the Bidder shall be given in the Schedule and this is subject to acceptance by the Purchaser. This description shall include details of surface preparation, rust inhibition, paint thickness, treatment of fasteners and painting of surfaces in contact with oil.

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out. Any subsequent damage occurring to the surface treatment up to the final delivery and offloading shall be made good by the Supplier.

### **Painting**

All paints shall be applied on clean, dry surfaces under suitable atmospheric and other conditions in accordance with the paint manufacturer's instructions. All paints used shall be compatible with each other and capable of being used as a system. The system shall be capable of performance for five years in the environment specified without any need for maintenance. No consecutive coats of paint shall be of the same shade. The minimum standards acceptable are:

- Cleaning by shot blasting to Grade Sa 2.5 of ISO 8501-1.
- All sheet steelwork shall be degreased, pickled and phosphate in accordance with IS 6005 - "Code of Practice for phosphate of iron and steel."
- All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth finish.
- Interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based undercoating, followed by one coat of phenolic based finishing paint to white colour followed by a final coat of anti-condensation white paint of a type and make to the approval of the Purchaser. A minimum overall paint film thickness of 150 microns shall be maintained throughout.
- Exterior steel work and metalwork, after preparation and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based under coating and two coats of micaceous iron oxide paint, then painted with a final coat of phenolic based hard gloss finishing paint of the Light Grey Shade No 631 of IS 5, to provide an overall minimum paint thickness of 200 microns.

### **Galvanizing**

All galvanizing shall be carried out by the hot dip process, in accordance with Specification ISO 1460 or IS 2629. However, high tensile steel nuts, bolts and spring washers shall be electro galvanized to service condition 4. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the

zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding etc. must be completed and all grease, paint, varnish, oil, welding slag etc. completely removed. All protuberances which would affect the life of galvanizing shall also be removed. The weight of zinc deposited shall be in accordance with that stated in standard BS 729 and shall be not less than 0.61 kg/sq. mtr with minimum thickness of 86 microns for items of thickness more than 5 mm, 0.46 kg/ sq. mtr. (64 microns) for items of thickness between 2 mm & 5 mm and 0.33 kg/ sq. mtr (47 microns) for items less than 2 mm thick. Parts shall not be galvanized if their shapes are such that the pickling solution cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint. In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Purchaser or that of his representative. Repair of galvanizing on site will generally not be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of splitter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Purchaser. All nuts and bolts shall be hot dip galvanized. Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. To avoid the formation of white rust, galvanized material shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

## **PART-2: TECHNICAL**

### **TYPE OF TRANSFORMER**

The transformers shall be double copper wound, three phase, oil immersed, **33/11.55 kV**, 50 Hz with on-load tap-changer for 10/14 MVA Transformer and 20/28 MVA Transformer

The transformers shall be naturally cooled type ONAN and forced cooled type ONAF.

### **RATED CAPACITY**

The MVA ratings shall be 10/14 MVA and 20/28 MVA based on ONAN/ONAF. Each transformer shall be capable of supplying its rated power continuously at all tap positions with rated voltage on the low voltage winding. The transformers shall also be capable of delivering rated current at an applied voltage equal to 105% of the rated voltage.

Each transformer shall be capable of supplying its rated power continuously under ambient temperature conditions without the temperature rise of the top oil exceeding 55°C and without the temperature rise of the windings as measured by resistance exceeding 60°C. The indicative ambient temperature conditions are as follows:

Maximum ambient temperature  
temperature  
ambient temperature 32°C

45°C Maximum daily average ambient  
35°C Maximum yearly weighted average

### **VOLTAGE RATIO**

Each transformer shall be supplied with an on load tap changer (as specified) connected to the high voltage winding. The tap changer shall have 17 tap positions and shall be so arranged as to give variations of transformation ratio in equal steps of 1.5% per step. The total range of the tap changer shall be from +6 percent to -18.0 percent. Tap 5 shall be the principal tap and the transformation ratio at tap 5 shall be 33.00 KV to 11.55 KV.

The no-load voltage ratios shall be as follows (for OLTC):

| Tap No. | High Voltage | Low Voltage |
|---------|--------------|-------------|
| 1       | 34.98 kV     | 11.55kV     |
| 5       | 33.00kV      | 11.55kV     |
| 17      | 27.06kV      | 11.55kV     |

## WINDING CONNECTIONS AND VECTOR GROUP

The transformers shall be connected in accordance with IEC Publication

76 as follows: HV Winding : Delta connected.  
LV Winding : Star connected.  
Vector Group : Dyn1

## INSULATION LEVELS

The transformers shall be designed and tested to the following insulation levels:

| Line<br>Terminals | Power Frequency<br>Voltage (rms.) | Lightning Impulse<br>Voltage (peak) |
|-------------------|-----------------------------------|-------------------------------------|
| 33kV              | 70 kV                             | 170 kV (1.2/50 sec.)                |
| 11kV              | 28 kV                             | 75 kV (1.2/50 $\mu$ sec.)           |

The windings shall be uniformly insulated and the low voltage neutral point shall be insulated for full voltage.

## IMPEDANCE VOLTAGE

The impedance on the principal tap shall be as

|                 |       |
|-----------------|-------|
| follows: 10 MVA | 8.0%  |
| 20MVA           | 10.0% |

The impedance voltage refers to the principal tapping. No negative tolerance on this percentage impedance is allowed. A positive tolerance of +10% is allowed.

Transformers of each rating shall have corresponding impedance per tap characteristics such that transformers of the same rating can be operated in parallel.

## SHORT CIRCUIT PERFORMANCE

The transformer shall be capable of withstanding the thermal and dynamic effects of short circuits, as specified in IEC 76-5 'Ability to withstand short circuits'.

Each transformer shall be capable of withstanding for 2 seconds a bolted metallic short circuit on the terminals of either winding with rated voltage on the other winding and the tap-changer in any position.

Short circuit tests shall have been carried out on the particular design of transformer offered, the test results shall be supplied with the bid.

## REGULATION

The regulation of each transformer from no-load to continuous rated output at 1.0 power factor and at 0.85 lagging power factor shall be as guaranteed in the Technical Data Schedules.

## FLUX DENSITY

Each transformer shall be capable of operating continuously with rated current and with system maximum voltage applied to the low voltage winding at a frequency of 96 per cent of rated frequency without exceeding the temperature rise specified in Clause 12.

The limit of flux density at normal voltage and frequency shall be subject to the requirements for losses, harmonics and noise suppression but in any event shall not exceed 1.6 Tesla.

The transformer core shall not be saturated at maximum system voltage i.e. 36 kV.



## **HARMONIC CURRENTS**

The transformers shall be designed with particular attention to the suppression of harmonic voltages, especially the 3rd, 5th and 7th harmonics, so as to eliminate wave form distortion and the possibility of high frequency disturbances, induction effect or of circulating current between neutral points at different transformer stations.

## **PARTIAL DISCHARGE**

Each transformer shall be partial discharge free up to 120% of rated voltage as the voltage is reduced from 150% of rated voltage i.e. there shall be no significant rise above background level.

## **VOLTAGE CONTROL**

### **General**

Transformers shall be provided with tap changers for varying the effective transformation ratio. Control schemes shall utilize 110V ac centre tap earthed voltage derived from the LV 3-Phase, 4-Wire system. Phase failure relays shall be provided to ensure a secure supply. Winding taps as called for in the Technical Requirements and Guarantee Schedule shall be provided on the high voltage winding. All terminals shall be clearly and permanently marked with numbers corresponding to the cables connected there to. Tap positions shall be numbered consecutively, ranging from one upwards. The tap positions shall be numbered so that by raising the tap position the LV voltage is increased

### **On-Load Tap**

#### **Changers General**

On-load tap changers are according as per IEC 60214 and be from MR, Germany/ ABB, Sweden/ Hitachi Energy, Sweden in order to comply with existing equipment standards. The On-Load Tap Changers shall be Vacuum Type.

Current making and breaking switches associated with the tap selectors or otherwise where combined with tap selectors shall be contained in a tank in which the head of oil is maintained by means completely independent of that on the transformer itself. Details of maintaining oil separation, oil levels, and detection of oil surges and provision of alarm and trip contacts shall be dependent on the design of tap-changer and be to the approval of the Engineer.

#### **Mechanisms**

The tap change mechanism shall be designed such that when a tap change has been initiated, it will be completed independently of the operation of the control relays and switches. If a failure of the auxiliary supply during tap change or any other contingency would result in that movement not being completed an approved means shall be provided to safeguard the transformer and its auxiliary equipment.

Limit switches shall be provided to prevent over-running of the tap changing mechanism. These shall be directly connected in the operating motor circuit. In addition, mechanical stops shall be fitted to prevent over-running of the mechanism under any conditions. For on-load tap change equipment these stops shall withstand the full torque of the driving mechanism without damage to the tap change equipment.

Thermal devices or other approved means shall be provided to protect the motor and control circuit.

A permanently legible lubrication chart shall be provided and fitted inside the tap change mechanism chamber.

#### **Local and Remote Control**

Equipment for local manual and electrical operation shall be provided in an indoor cubicle complying with Section-2. A thermostat controlled anti-condensation heater is to be provided in the cubicle. Electrical remote control equipment shall also be supplied as specified.

The following operating conditions are to apply to the on-load tap changer controls:-

- a) It must not be possible to operate the electric drive when the manual operating gear is in use.
- b) It must not be possible for two electric control points to be in operation at the same time.

- c) Operation from the local or remote control switch shall cause one tap movement only, unless the control switch is returned to the off position between successive operations.
- d) It must not be possible for any transformer operating in parallel with one or more transformers in a group to be more than one tap out of step with the other transformers in the group.
- e) All electrical control switches and local manual operating gear shall be clearly labeled in an approved manner to indicate the direction of tap changing, i.e. raise and lower tap number.
- f) Emergency stop push-button at local and remote control positions.

### **Indication**

Apparatus of an approved type shall be provided on each transformer:

- a) To give indication mechanically at the transformer and electrically at the remote control point of the number of the tapping in use.
- b) To give electrical indication, separate from that specified above, of tap position.
- c) To give indication at the remote control point that a tap change is in progress; this indication to continue until the tap change is completed.
- d) To give indication at the remote control point when the transformers operating in parallel are operation out of step.
- e) To indicate at the tap change mechanism the number of operations completed by the equipment.

### **Automatic Voltage Control**

Automatic Voltage Control Relay shall be from 'MR' Germany/ABB, Sweden/ Hitachi Energy, Sweden which is also suitable for control of transformers in parallel. This Automatic Voltage Control Relay should have the IEC 61850 protocol type. This relay shall be capable for SCADA operation. Automatic Voltage Control Relay shall be from same manufacturer of OLTC.

In addition to the methods of control included in this specification, the following methods shall also be provided. This is for future addition of a similar transformer and associated parallel operation.

- a) Automatic Independent – It shall be possible to select automatic independent control for each transformer irrespective of the method of control selected for any other of the associated transformers.
- b) Automatic parallel – It shall be possible to select any transformer for master or follower control. It must not be possible to operate any tap changer by remote or local electrical manual control while the equipment is switched for automatic operation.

### **Voltage Regulating Relays**

Automatic voltage control shall be initiated by a voltage regulating relay of an approved type and suitable for flush mounting. The relay shall operate from the nominal reference voltage stated in the Schedule of Requirements derived from a circuit mounted LV voltage transformer having Class 1.0 accuracy to IEC 60186 and the relay voltage reference balance point shall be adjustable.

The relay bandwidth shall preferably be adjustable to any value between 1.5 times and 2.5 times the transformer tap step percentage, the nominal setting being twice the transformer tap step percentage.

The relay shall be insensitive to frequency variation between the limits of 47Hz and 51Hz. The relay shall be complete with a time delay element adjustable between 10 and 120 seconds. The relay shall also incorporate an under voltage blocking facility which renders the control inoperative if the reference voltage falls below 80 percent of the nominal value with automatic restoration of control when the reference voltage rises to 85 percent of nominal value.

On each transformer the voltage transformer supply to the voltage regulating relay shall be monitored for partial or complete failure. The specified indicating lamp and alarm will be inoperative when the circuit-breaker controlling the lower voltage side of the transformer is open and also that when the tap changer is on control other than automatic control.

### **COOLING AND TEMPERATURE CONTROL**

The banks of cooling radiators shall be detachable from the tank for transport and maintenance. Shut-off valves shall be provided on the tanks of the transformers for this purpose. An air-vent and draining plug shall be provided on each radiator bank. All external surfaces of the radiators shall be hot dip galvanized as specified in Sub-clause 13.2, Part 1 of this document. Temperature control equipment

shall be housed in a local control box mounted on the side of the transformer. A 150mm diameter dial thermometer shall be provided to indicate the temperature of the top oil in the transformer. This thermometer shall be fitted in such a way that it can easily be read from ground level through a window in the door of the

control box. The thermometer shall be fitted with two adjustable contacts, one connected to give an alarm and one to trip associated circuit breakers. It shall also be fitted with a maximum temperature pointer which shall be re-settable by hand.

A similar dial thermometer shall be provided in the control box to indicate winding temperature. This thermometer shall have two sets of adjustable contacts one connected to give an alarm and the other to trip associated circuit breakers and a maximum temperature pointer which shall be re-settable by hand. The minimum range of these contacts shall be 50 °C to 100 °C for alarm and 60 °C to 120 °C for trip. The temperature control box shall be weatherproofed to IP55 of IEC 529 or IS 2147 equivalent.

### **Cooling Plant General**

Radiators and coolers shall be hot-dip galvanized, designed so that all painted surfaces can be thoroughly cleaned and easily painted in situ with brush or spray gun. The design shall also avoid pockets in which water can collect and shall be capable of withstanding the pressure tests specified in the schedule of requirements for the transformer main tank.

The clearance between any oil or other pipe work and live parts shall be not less than the minimum clearances stated in the Schedule of Requirements.

### **Radiators connected directly to Tank**

Where built-on radiators are used, each radiator shall be connected to the main tank through flanged valves. Plugs shall be fitted at the top of each radiator for air release and at the bottom for draining.

A valve shall be provided on the tank at each point of connection to the tank.

### **Cooler Banks**

Each cooler bank shall be provided with:-

- A) A valve at each point of connection to the tank.
- B) A valve at each point of connection of radiators
- C) Loose blanking plates for blanking off the main oil connections.
- D) A 50mm filter valve at the top of each cooler bank.
- E) A 50mm drain valve at the lowest point of each interconnecting oil pipe.
- F) A thermometer pocket, fitted with captive screw cap in the inlet and in the outlet oil pipes.
- G) Air release and drain plugs on each radiator.

The omission of any, or the provision of alternative, arrangements to the above requirements will not be accepted unless approved in writing by the Engineer before manufacture.

### **Forced Cooling**

The type of forced cooling shall be as stated in the Schedule of Requirements.

Forced cooling equipment of transformers of similar rating and design shall be completely interchangeable, one with the other, without modification on Site.

### **Oil Pipes and Flanges**

All oil piping necessary for the connecting of each transformer to its conservator, cooler banks etc. shall be supplied and erected under this Contract.

The oil piping shall be of approved material with machined flanged joints. Copper pipe work is to comply with BS 61. Dimensions of steel pipes shall be in accordance with BS 3600 and the drilling of all pipe flanges shall with BS 4504.

An approved expansion piece shall be provided in each oil pipe connection between the transformer and each oil cooler bank.

All necessary pipe supports, foundation bolts and other attachments are to be provided. It shall be possible to drain any section of pipe work independently of the rest and drain valves or plugs shall be provided as necessary to meet this requirement.

### **Air Blowers**

Air blowers for forced air-cooling shall be of approved make and design and be suitable for continuous operation out-of-doors. They shall also be capable of withstanding the stresses imposed when brought up to speed by the direct application of full line voltage to the motor.

To reduce noise to the practical minimum, motors shall be mounted independently from the coolers, alternatively, an approved form of anti-vibration mounting shall be provided.

It shall be possible to remove the blower, complete with motor, without disturbing or dismantling the cooler structure framework.

Blades shall be of material subject to approval.

Blower casings shall be made of galvanized steel of thickness not less than 2.6 mm (14 S.W.G.) and shall be suitably stiffened by angles or tees.

Galvanized wire guards with mesh not exceeding 12.5mm shall be provided to prevent accidental contact with the blades. Guards shall also be provided over all moving parts. Guards shall be designed such that blades and other moving parts cannot be touched by test fingers to IEC 529.

### **Cooler Control**

Where forced cooling using multiple small single-phase motors is employed, the motors in each cooling bank shall be grouped so as to form a balanced three-phase load.

Each motor or group of motors shall be provided with a three-pole electrically operated contractor and with control gear of approved design for starting and stopping manually.

Where forced cooling is used on transformers, provision shall be included under this contract for automatic starting and stopping from contacts on the winding temperature indicating devices as specified. The control equipment shall be provided with a short time delay device to prevent the starting of more than one motor, or group of motors in the case of multiple cooling, at a time.

Where motors are operated in groups, the group protection shall be arranged so that it will operate satisfactorily in the event of a fault occurring in a single motor.

The control arrangements are to be designed to prevent the starting of motors totaling more than 15 KW simultaneously, either manually or automatically. Phase failure relays are to be provided in the main cooler supply circuit.

All contacts and other parts which may require periodic renewal, adjustment or inspection shall be readily accessible.

All wiring for the control gear accommodated in the marshalling kiosk, together with all necessary cable boxes and terminations and all wiring between the marshalling kiosk and the motors, shall be included in the contract. Each box shall have a hinged gasketed door lockable by padlock. Solar gain can give rise to high temperature in a local control box. Adequate ventilation shall be provided to ensure that all equipment contained therein shall operate satisfactorily under these conditions.

A terminal block with 10% spare terminals shall be provided in each temperature control box.

## **TANK AND ACCESSORIES**

### **General**

The transformer tank shall be skid mounted type. The transformer tank shall be designed so that the complete transformer with oil and excluding conservator and radiators can be lifted and transported without permanent deformation or oil leakage. The tank and cover including the stiffeners shall be designed in such a manner as to leave no external pockets in which water can lodge, or internal pockets where gas/air can collect. All fittings shall be designed so as to prevent entry of air or leakage of oil from the tank. All pipes, shall be externally welded to the tank wall. The tank and cover shall be of structural quality, weld-able high tensile steel with a minimum thickness of 3mm. All welding shall be stress relieved. The requirement of post weld heat treatment of tank/ stress relieving shall be based on recommendation of BS-5500.

The tank lid shall not be welded shut, but shall be secured by bolts and provided with suitable oil-tight gasket. The tank is to withstand vacuum up to 500mm of mercury for 10 MVA and 20 MVA transformers and any pressure of oil developed during operation conditions including short circuits.

### **Surface Treatment**

The transformer tank and accessories shall be adequately protected against corrosion. The inside of the tank shall be painted with an approved oil resisting varnish. The outside of the tank shall be painted as specified in Sub-clause 13.1, Part 1 of this document.

### **Conservator Tank:**

A conservator tank shall be provided of adequate capacity between lowest and highest visible levels to meet expansion of oil from 0 °C to 100 °C. A suitable oil level gauge shall be located on the tank so that it can be easily read from ground level. The gauge shall be graduated for temperatures of 0 °C, +45 °C and +90 °C.

Each gauge shall be provided with contacts for separate low oil level alarm and trip signals. The conservator shall be fitted with a filling hole with cap and drain valve. It shall be inclined at about 5 degrees towards the drain valve. The pipe connecting the conservator to the main tank shall project 20mm above the bottom of the conservator for collection of impurities.

### **Breather**

The conservator tank shall be fitted with a breather in which silica gel is the dehydrating agent from any country of Europe, USA and Japan. The breather shall be a molded type transparent case of adequate size and so designed that:

- the passage of air through the silica gel does not give rise to any excess pressure rise;
- silica gel crystal of not less than 5mm. size is used;
- the silica gel is sealed from the external atmosphere by means of an oil seal;
- the moisture absorption indicated by a change in color of the crystals can be easily observed from a distance;
- the breather mounting height facilitates maintenance from ground level without switching out the transformer.

### **Explosion Vent or Pressure Relief Device**

An explosion vent or pressure relief device shall be provided to release any severe build-up of pressure within the tank. The vent shall be designed such that in the event of an explosion, rain, sand or any other foreign bodies are prevented from getting into the tank. The vent shall be positioned so as to direct the explosion safely into the oil pit.

### **Oil Sampling Devices**

Oil sampling devices shall be fitted to the main tank. They shall be located suitably for easy access especially during maintenance, one near the bottom of the tank and one near the top.

## **Oil Filtration**

Two 50mm bore filter valves shall be fitted to the tank, one on the top and the other diagonally opposite on the bottom.

## **Lifting Lugs/Eyes**

Lifting lugs shall be provided for supporting the weight of the transformer including core and windings and fittings and with the tank filled with oil.

## **Jacking Pads**

Four jacking pads shall be provided near the corners of the tank of each transformer and approximately 400mm above the lowest part of the tank. These pads shall be designed to take the complete weight of the transformer filled with oil.

## **Hauling Eyes**

Hauling eyes shall be provided on all sides of the transformer.

## **Earthing Terminals**

Earthing terminals shall be provided on the transformer close to each of the four corners of the tank to facilitate easy earthing of the transformer on site.

## **Oil Valves**

In addition to the valves already mentioned, a drain valve shall be provided near the bottom of the tank. All oil valves shall be provided with means for securing them in the open or closed position.

## **TERMINAL BUSHING AND CONNECTIONS**

### **General**

Transformers are to be provided with outdoor type bushing insulators and cable box on the LV side. HV and LV bushings shall be from Europe, USA or Japan origin.

All bushings shall comply with IEC 60137 and the minimum creepage distance for outdoor bushings shall not be less than 25mm per kV of rated voltage between phases. Outdoor bushing insulators shall be provided with adjustable arcing horns and for rated voltages of 36 kV and lower these shall be of the duplex gap type.

Bushings shall be of sealed construction suitable for service under the very humid conditions at site and, addition, for the very rapid cooling of equipment exposed to direct sunlight when this is followed by sudden heavy rainstorms.

Typical sections of bushing insulators showing the internal construction, method of securing the top cap and methods of sealing shall be included in the Tender.

Completely immersed bushings and lower voltage outdoor immersed bushings may be of other type of construction, subject to the approval of the Engineer but bushings of resin bonded paper construction are not permitted. The 33 kV bushings shall be porcelain (solid or condenser type). On all condenser bushings a tapping shall be brought out to a separate terminal for testing purposes on Site.

Special precautions shall be taken to exclude moisture from any paper insulation during manufacture, assembly, transport and erection. Terminal arrangement of LV cable box position & neutral bushing position shall be as per approved drawings.

### **Porcelain**

Hollow porcelain shall meet the test requirements of IEC 60233 and shall be sound, free from defects and thoroughly vitrified. Designs based on jointed porcelains will not be acceptable. The glaze must not be depended upon for insulation. The glaze shall be smooth, hard, of a uniform shade of brown and shall cover completely all exposed parts of the insulator. Outdoor insulators and fittings shall be unaffected by atmospheric conditions producing weathering, acids, alkalis, dust and rapid changes in temperature that may be experienced under working conditions.

The porcelain must not engage directly with hard metal and, where necessary, gaskets shall be interposed between the porcelain and the fittings. All porcelain clamping surfaces in contact with gaskets shall be accurately ground and free from glaze.

All fixing material used shall be of suitable quality and properly applied and must not enter into chemical action with the metal parts or cause fracture by expansion in service. Cement thickness are to as small and even as possible and proper care is to be taken to centre and locate the individual parts correctly during cementing.

All porcelain insulators shall be designed to facilitate cleaning.

### **Marking**

Each porcelain insulator shall have marked upon it the manufacturer's name or identification mark and year of manufacture.

These marks shall be clearly legible after assemble of fittings and shall be imprinted before firing, not impressed.

When a batch of insulators bearing a certain identification mark has been rejected, no further insulators bearing this mark shall be submitted and the Contractor shall satisfy the Engineer that adequate steps will be taken to mark or segregate the insulators constituting the rejected batch in such a way that there can be no possibility of the insulators being re-submitted for the test or supplied for the use of the Employer.

Each complete bushing shall be marked with the manufacturer's name or identification mark, year of manufacture, serial number, electrical and mechanical characteristics in accordance with IEC 60137.

### **Mounting of Bushings**

Bushing insulators shall be mounted on the tank in a manner such that the external connections can be taken away clear of all obstacles. Neutral bushings shall be mounted in a position from which connection can be taken to a neutral current transformer mounted on a bracket secured to the transformer tank. The current transformer will be supplied by the switchgear manufacturer but provision shall be made on the tank for mounting to the Engineer's requirements.

The clearances from phase to earth must not be less than those stated in the Technical Requirements and Guarantee Schedule.

A flexible pull-through lead suitably suited to the end of the winding copper shall be provided for the bushings and is to be continuous to the connector which is housed in the helmet of the bushings. When bushings with an under-oil end of a re-entrant type are used the associated flexible pull-through lead is to be fitted with suitably designed gas bubble deflector. The bushing flanges must not be of re-entrant shape which may trap air.

Clamps and fittings made of steel or malleable iron shall be galvanized and all bolt threads are to be greased before erection.

### **Tests**

Routine, sample and type tests of Bushing shall be carried out in accordance with the specified standards. Type tests shall also be carried out unless approved type test evidence is submitted. These tests shall include temperature cycle and porosity tests. The following standards shall apply:-

- IEC 60233(BS 4963) for hollow porcelains.
- IEC 60137 for bushings.
- IEC 60148 and 60273 (BS 3297) for high voltage post insulators.
- IEC 60383 and 60305 (BS 137 Part 1 and Part 2) for cap and pin string insulators.

## **CORE AND WINDINGS**

### **General**

The winding shall be of high-conductivity electrolytic copper and transposed winding conductors shall be employed where applicable. Maximum current density for HV and LV windings should not exceed 2.5 A/mm<sup>2</sup>.

The Windings shall have uniform insulation as defined in IEC 76. All neutral points shall be grounded.

The windings shall be located in a manner which will ensure that they remain electro-magnetically balanced and that their magnetic centers remain coincident under all conditions of operation.

The windings shall also be thoroughly dried and shrunk by the application of axial pressure for such length of time as will ensure that further shrinkage will not occur in service.

The windings and leads of all transformers shall be braced to withstand the shocks which may occur through rough handling and vibration during transport, switching and other transient service conditions including external short circuit

### **Core**

The core shall be constructed from high grade, non-ageing, cold rolled grain oriented silicon steel laminations or superior material. The core and winding shall be capable of withstanding shocks during transport, installation and service. Provision shall be made to prevent movement of the core and windings relative to the tank during these conditions and also during short circuits.

The design shall avoid the presence of pockets which would prevent the complete emptying of the tank through the drain valve.

### **Windings**

The winding conductor shall be of electrolytic copper, free from burs and splinter. Paper shall be used for conductor insulation. The insulation shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse. It shall be non catalytic and chemically inert in transformer oil during normal service.

The stacks of windings are to receive adequate shrinkage treatment.

The windings and connections are to be braced to withstand shocks during transport, switching, short circuit or other transient conditions. The manufacturer must provide the thermal damage curve or thermal damage description of the transformer winding or the transformer as per relevant IEC standard.

The winding shall be of electrolytic copper, free from burs and splinter. Paper shall be used for conductor insulation.

## **INTERNAL EARTHING**

### **General**

All metal parts of the transformer, with the exception of the individual core laminations, core bolts and associated individual clamping plates, shall be maintained fixed potential.

### **Earthing of Core clamping Structure**

The top main core clamping structure shall be connected to the tank body by a copper strap. The bottom main core clamping structure shall be earthed by one or more of the following methods:

- a) by connection through vertical tie rods to the top structure;
- b) by direct metal-to-metal contact with the tank base maintained by the weight of the core and windings;
- c) by connection to the top structure on the same side of the core as the main earth connection to the tank.



## **Earthing of Magnetic Circuits**

The magnetic circuit shall be earthed to the clamping structure at one point only through a removable link placed in an accessible position just beneath an inspection opening in the tank cover and which, by disconnection, will enable the insulation between the core and clamping plates, etc., to be tested at voltages up to 2 kV. The link shall have no detachable components and the connection to the link shall be on the same side of the core as the main earth connection. These requirements are compulsory.

All insulating barriers within magnetic circuits shall be bridged by means of aluminum or tinned copper strips, so inserted as to maintain electrical continuity.

## **Earthing of Coil Clamping Rings**

Where coil clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of the transformer as the main earth connection.

## **Size of Earthing connections**

Main earthing connections shall have a cross-sectional area of not less than 80 sq.mm but connections inserted between laminations may have cross-sectional areas reduced to 20 sq.mm when in close thermal contact with the core.

## **TANKS AND ANCILLARY EQUIPMENT**

### **Transformer Tanks**

Each transformer shall be enclosed in a suitably stiffened weld-able high tensile steel tank such that the transformer can be lifted and transported without permanent deformation or oil leakage. The construction shall employ weld-able structural high tensile steel of an approved grade to BS 7613 and BS EN10029. The final coat colour of Transformers shall be to Munsell notation N5Y-7/l.

Lifting lugs shall be provided, suitable for the weight of the transformer, including core and windings, fittings, and with the tank filled with oil. Each tank shall be provided with at least four jacking lugs, and where required, with lugs suitably positioned for transport on a beam transporter. Haulage lugs should also be provided to enable a cable to be used safely for haulage in any direction.

The transformer tank shall be capable of withstanding vacuum up to 500mm of mercury without defection exceeding the value stated in the Schedule of Requirements.

Where the design of the tank is such that the bottom plates will be in direct contact with the surface of the foundations. The base of each tank shall be so designed that it is possible to move the complete transformer unit in any direction without injury when using rollers, plates, or rails

All joints, other than those which may have to be broken, shall be welded.

The tank and cover shall be designed in such a manner as to leave no external pockets in which water can lodge, no internal pockets in which oil can remain when draining the tank or in which air can be trapped when filling the tank, and to provide easy access to all external surfaces for painting. Where cooling tubes are used, each tube shall be of heavy gauge steel welded into the tank sides, top and bottom.

Each tank cover shall be of adequate strength, must not distort when lifted and shall be provided with suitable flanges having sufficient and properly spaced bolts. Inspection openings shall be provided to give access to the internal connections of bushings, winding connections and earthing links. Each opening shall be correctly located and must be of ample size for the purpose for which it is intended. All inspection covers shall be provided with lifting handles.

It must be possible to remove any bushing without removing the tank cover.

Pockets shall be provided for a stem type thermometer and for the bulbs of temperature indicators where specified. These pockets shall be located in the position of maximum oil temperature and it must be possible to remove any bulb without lowering the oil level in the tank. Captive screwed caps shall be

provided to prevent the ingress of water to the thermometer pockets when they are not in use. Where called for in the Technical Requirements and Guarantee Schedule, accommodation shall be provided for outdoor weatherproof neutral current transformers.

A ladder shall be provided on one side of the tank as a means for inspection and access to the top of the transformer. The lower section of the ladder shall be equipped with a barrier complete with provision for locking with a padlock.

### **Conservator Tanks, Breathers and Air Dryers**

Each transformer shall be provided with an overhead conservator tank formed of substantial steel plates and arranged above the highest point of the oil circulating system. Connections into the main tank shall be at the highest point to prevent the trapping of air or gas under the main tank cover. A steel ladder shall be fixed between conservator top and the transformer top cover.

The capacity of each conservator tank shall be adequate for the expansion and contraction of oil in the whole system under the specified operating conditions. Conservator tanks shall also be provided with a cleaning door, filling cap, drain valve with captive cap and an oil level indicator with minimum and maximum levels indicated. The normal level at an oil temperature of 25°C shall be indicated and the minimum and maximum levels shall also be correlated with oil temperature markings. The temperature markings shall preferably be integral with the level indicating device. The Oil level indicator shall be from MR. Germany or equivalent European class.

The location of the conservator tank shall be so arranged that it does not obstruct the passage of high voltage conductors immediately above the transformer.

The pipe work between the conservator and the transformer tank shall comply with the standard requirements and a valve shall be provided at the conservator to cut-off the oil supply to the tank.

Each conservator shall be fitted with an air cell which shall be connected to a silica gel breather of a type which permits the silica gel content to be removed for drying. Due to the climatic conditions at site, this breather shall be larger than would be fitted for use in a temperate climate. All breathers shall be mounted at a height of approximately 1400 mm above ground level. The silica gel container shall be fully transparent.

### **Valves**

Each transformer shall be fitted with the following valves as a minimum requirement:

#### **Main Tank**

- a) One 50mm bore filter valve located near to the top of the tank.
- b) One 50 mm bore filter valve located near to the bottom of the tank and diagonally opposite to the filter valve required against (A). Where design permits, this valve may be combined with item (C).
- c) One 50mm drain valve with such arrangements as may be necessary inside the tank to ensure that the tank can be completely drained of oil as far as practicable. This valve shall also be provided with an approved oil sampling device.
- d) One valve between the main tank and gas actuated relay, complete with bypass facility to facilitate removal of relay and maintain oil flow.

#### **Conservator**

- a) One valve between the conservator and gas actuated relay for the main tank and where appropriate, for the tap change diverter switch tank complete with bypass for Buchholz relay to facilitate maintenance of the relay.
- b) One drain valve for oil conservator tank so arranged that the tank can be completely drained of all oil.

### **Radiators and Cooler Banks**

a) Valves at each point of connection to the tank.

The two valves 28.3.1 (d) and 28.3.2 (a) arrangement across the gas actuated relay are to be connected with an oil pipe work bypass facility to facilitate removal of the relay, due to failure etc, and still maintain the oil flow system between the conservator and main tank.

Blank flanges, plates or captive screw caps shall be fitted to all valves and pipe ends not normally connected in service.

The omission of any, or the provision of alternative arrangements to the above requirements, will not be accepted unless approved in writing by the Engineer before manufacture.

### **Joints and Gaskets**

All joint faces shall be arranged to prevent the ingress of water or leakage of oil with a minimum of gasket surface exposed to the action of oil or air.

Oil resisting synthetic rubber gaskets are not permissible except where the synthetic rubber is used as a bonding medium for cork, or where metal inserts are provided to limit compression.

Gaskets shall have sufficient thickness consistent with the provision of a good seal and full details of all gasket sealing arrangements shall be shown on the Plant drawings.

All gaskets shall be closed design (without open ends) and shall be one piece only. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. No gaskets shall be used in which the material of the gasket is mounted on a textile backing. Gaskets of neoprene or any kind of impregnated/ bonded core or cork only which can easily damage by over pressing is not acceptable. Use of hemp as gasket material is also not acceptable.

### **Pressure Relief device**

An approved pressure relief device of sufficient size for the rapid release of over pressure that may be generated in the tank, and designed to operate at a static pressure lower than the hydraulic test pressure, shall be provided. It shall be of the spring operated valve type and shall be provided with one set of normally open signaling contacts which will be used for trip alarm purposes. The pressure relief device shall be from 'MR' or equivalent European made.

The relief device is to be mounted on the tank cover and is to be provided with a skirt to project at least 25mm into the tank to prevent gas accumulation. Discharge of oil shall be directed away from the transformer top cover and clear of any operating position.

### **Earthing Terminals**

Two substantial steel flag type terminals having two 14mm diameter holes on 55mm centers shall be located one on either side and near to the bottom of the transformer to facilitate connection to the local earthing system.

### **Rating, Diagram and Valve Plates**

The following plates, or an approved combined plate, shall be fixed to each transformer tank at an average height of 1500mm above the ground level:-

a) A rating plate bearing the data specified in IEC 76 Part 1. This plate shall also include the short-circuit current rating and time-factor for each winding.

b) A Diagram plate showing in an approved manner the internal connections and the voltage vector relationship of the several windings, in accordance with IEC 76 Part1 with the transformer voltage ratio for each tap and, in addition a plan view of the transformer giving the correct physical relationship of the terminals.

c) A plate showing the location and function of all valves and air release cocks or plugs. This plate shall also if necessary warn operators to refer to the Maintenance Instructions before applying vacuum.

Plates are to be of stainless steel or other approved material capable of withstanding the rigorous of continuous outdoor service at site.

### **STATION AUXILIARY TRANSFORMER:**

The Supplier shall supply Station Auxiliary transformer with 10 MVA & 20 MVA OLTC Type only.

Auxiliary transformers shall be sealed, two- electrolytic Cu winding, three-phase, oil immersed, ONAN, with Off Load Tap Changing, suitable for outdoor use.

All transformers shall be 33/0.433kV and have a continuous rating of 200 kVA, shall be capable of supplying the maximum continuous rating for all tap positions and maintaining rated voltage on the low voltage winding, under the maximum ambient temperature conditions, without the temperature rise of the top oil exceeding 55°C or the temperature rise of the windings as measured by resistance exceeding 60°C.

Transformers shall be in accordance with the relevant IEC standard and this specification. Refer to the Schedule of Technical Particulars and Guarantees for other relevant requirements.

Off-load tap-changing shall be carried out by means of an external hand-operated tapping switch mounted on the side of the tank. All phases of the tapping switch must be operated by one hand wheel.

The tapping switch shall have a spring-loaded captive bolt or other approved means on the moving part which positively locates the switch correctly at each tapping position. This bolt must be lockable at each tapping position and shall be provided with a suitable padlock and keys. Moving the switch from one tapping position to another shall require that the bolt be withdrawn by hand from its locating socket on the transformer tank against the spring pressure.

Tap-position numbers corresponding to the tapping switch bolt-locating sockets shall be cast or engraved in a metal indication plate fixed to the tank and a keyed metal pointer on the tapping switch operating handle shall show clearly at which tapping number the transformer is operating.

All tap-position indicators shall be marked with one integer for each tap position, beginning at number 1. Adjacent taps shall be numbered consecutively in such a manner that when moving a tap to a new tapping position which has a higher number, the no-load output voltage of the untapped winding increases.

Station transformer must be facilitated with PRD and other relevant protection (if required). Necessary number of auxiliary relays with NO-NC contacts should be installed with line incomer feeder PCM and connected with proper indication circuit.

### **Technical Requirements**

Transformers shall be provided with the following fittings:

- Off-load tap changer.
- Oil filler plug and drain valve.
- Thermometer.
- Pressure release device.
- Four lifting lugs.
- Air insulated terminals for 33kV and 0.433 kV connections using adequately sized conductor.
- Galvanised tank and radiators.

### **CABLE TERMINATIONS AND GLANDS**

#### **Cable Boxes**

The transformers shall be provided with cable boxes with all necessary fittings and attachments **as** per approval of Drawings (submitted by the bidder) by the proper authority of BREB . Cable boxes shall be of adequate proportions and designed in accordance with BS 6435 in such the manner that they can be opened for inspection without disturbing the gland plate or incoming cable(s). Cable boxes shall be designed for ease of access for jointing and connecting the cable. They shall be constructed to minimize the danger of fragmentation; cast iron boxes shall not be used. The cable box shall be of such a design as to prevent ingress of moisture. Where blind tapped holes have to be provided, studs shall be used and not bolts or set screws.

All gaskets, unless otherwise approved, shall be in one continuous piece without joints. Gaskets shall not be compressed before use. Provision shall be made for earthing the body of each cable box. Removable blank gland plates and suitable type and size of cable glands shall be supplied and fitted for termination of the cables.

Dehydrating breather and draining holes protected by 1 mm aperture mesh shall be incorporated at the base of the box to avoid moisture condensation within cable box and ensure drainage of condensation respectively. Cable boxes shall be provided with suitable means for clamping the armor wires of the cables.

Gland plates for single core cable shall be made from non-ferrous metal. The contractor shall guarantee (test certificate shall be supplied to prove) that the air clearances and the creep age path on the bushing connecting to the associated switchgear or transformers shall be such that the completed installation shall withstand in air the impulse and power frequency voltages appropriate to the plant. The cable box clearances would meet the requirements for BS 6435 for partially insulated cable boxes. An earthing terminal shall be provided in each sealing end chamber to which the connections from the transformer winding can be earthed during cable testing. Cable boxes shall be provided on 33kV/11kV sides suitable for air insulations terminations of XLPE Copper Conductor cables of minimum sizes as mentioned below:

## **TEMPERATURE AND ALARM DEVICES**

### **Temperature Indicating Devices and Alarms**

The transformers shall be provided with approved devices of Kilhstrom for indicating the top oil temperature and hottest spot winding temperatures. The devices shall have a dial type indicator and, in addition, a pointer to register the highest

temperature reached. Each winding temperature device shall have four separate contacts fitted, two of which shall be used to control the two groups of cooling plant motors (i.e. AF1 and AF2), one to give an alarm and one to trip the associated circuit breakers. The Temperature indicating device shall be from MR Germany or equivalent European class.

To simulate indication of the hottest spot temperature of the winding the device shall comprise a current transformer associated with one phase only and a heating device designed to operate continuously at 130 percent of transformer CMR current and for 30 minutes at 150 percent of CMR current, associated with a sensing bulb installed in an oil tight pocket in the transformer top oil.

The winding temperature indicators (WTI) shall be housed in the marshalling cubicle. The tripping contacts of the winding temperature indicators shall be adjustable to close between 80°C and 150°C and to re-open when the temperature has fallen by not more than 10°C.

The alarm contacts and the contacts used to control the cooling plant motors on the above devices shall be adjustable to close between 50°C and 100°C and to re-open when the temperature has fallen by a desired amount between 10°C and 15°C.

All contacts shall be adjustable to a scale and must be accessible on removal of the relay cover. Alarm and trip circuit contacts shall be suitable for making or breaking 150 VA between the limits of 30 volts and 250 volts AC or DC and of making 500 VA between the limits of 110 and 250V DC. Cooler motor control contacts shall be suitable for operating the cooler contractors direct or, if necessary, through an interposing relay.

The temperature indicators in the marshalling kiosk shall be so designed that it is possible to move the pointers by hand for the purpose of checking the operation of the contacts and associated equipment. The working parts of the instrument shall be made visible by the provision of cut-away dials and glass-fronted covers and all setting and error adjustment devices shall be easily accessible.

Connections shall be brought from the device to terminal boards placed inside the

marshalling cubicle. Terminals, links and a 63mm moving iron ammeter shall be provided in

the marshalling kiosk for each WTI for:

- a) Checking the output of the current transformer.
- b) Testing the current transformer and thermal image characteristics.

- c) Disconnecting the bulb heaters from the current transformer secondary circuit to enable the instrument to be used as an oil temperature indicator. Links shall be provided as shown on the drawing enclosed with the offer.

### **Gas and Oil-Actuated Relays (Buchholz Relays)**

Each transformer shall be fitted with gas and oil-actuated relay equipment having alarm contacts which close on collection of gas or low oil level, and tripping contacts which close following oil surge conditions. The Relay shall be from MR, Germany or equivalent European class.

Each gas and oil-actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay by inserting air in the relay. The floats of the Buchholz shall be solid body. Each relay shall be fitted with UV protective covered glass window for indication of gas volume.

To allow gas to be collected at ground level, a small bore pipe shall be connected to the gas release cock of the gas and oil-actuated relay and brought down to a point approximately 1400mm above ground level, where it shall be terminated by a cock which shall have provision for locking to prevent unauthorized operation.

The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that multi operation of the relay will not take place under normal service conditions, including starting or stopping of oil circulating pumps, whether by manual or automatic control under all operating temperatures.

The pipe work shall be so arranged that all gas arising from the transformer will pass into the gas and oil-actuated relay. The oil circuit through the relay must not form a delivery path in parallel with any circulating oil pipe, nor is it to be fed into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.

When a transformer is provided with two conservators, the gas and oil-actuated relays shall be arranged as follows:

- a) If the two conservators are connected to the transformer by a common oil pipe, one relay shall be installed in the common pipe.
- b) If the two conservators are piped separately to the transformer, two relays shall be installed, one in each pipe connection.

The clearance between oil pipe work and live metal shall be not less than the minimum clearances stated in the schedule of requirement.

### **TRANSFORMER OIL**

Insulating oil shall comply with the requirements of IEC 60296. Insulating oil shall be provided by the Contractor for all oil-filled apparatus and 10% excess shall be provided for topping up purposes in sealed drums. The Contractor shall satisfy himself that suitable oil treatment facilities are available at Site for his use. If the Contractor is unable to obtain written assurances to this effect he shall provide such oil treatment facilities as required to meet the specification, at no additional cost.

The Contractor shall supply the first filling of all insulating oil required for the operation of the Plant and, after treatment, a test shall be made in the Engineer's presence to prove that the breakdown voltage is at least 60kV at 2.5mm electrode gap.

| <b>Transformer Oil</b>          |                                                   |
|---------------------------------|---------------------------------------------------|
| Application                     | Insulating mineral oil for Transformer            |
| Grade of oil                    | Class-1                                           |
| <b>a) Physical Properties</b>   |                                                   |
| Appearance                      | Liquid and free from suspended matter or sediment |
| Density at 20°C                 | 0.895g/cm <sup>3</sup> (maximum)                  |
| Flash point (Closed cup)        | 140°C (minimum)                                   |
| Kinematics Viscosity at 40°C    | 12 mm <sup>2</sup> /S. (Maximum)                  |
| Pour point                      | -30°C (maximum)                                   |
| <b>b) Electrical Properties</b> |                                                   |

|                                                                                                                        |                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dielectric Strength at 50 Hz (with 2.5 mm standard gap and 40 mm standard depth)                                       | On new untreated oil, the break down voltage shall be >60KV.                                                                                                              |
| Loss tangent/ Dielectric dissipation factor at temp 90° C, stress 500V/ mm to 1000 v/ mm and frequency 40 Hz to 62 Hz. | 0.005 (maximum)                                                                                                                                                           |
| <b>c) Chemical Properties</b>                                                                                          |                                                                                                                                                                           |
| Acidity                                                                                                                | 0.01 mg KOH/g (maximum)                                                                                                                                                   |
| Neutralization value after oxidation                                                                                   | 0.40mg KOH/g (maximum)                                                                                                                                                    |
| Total sludge after oxidation                                                                                           | 0.10% weight (maximum)                                                                                                                                                    |
| PCB Content                                                                                                            | Free from PCB                                                                                                                                                             |
| d) Standards                                                                                                           | Performance, testing and any other parameter of oil shall comply with the latest revision of the relevant standards BS 148; 1972 IEC – 60296 or latest revision there on. |

### **SURGE ARRESTERS (Station Class):**

Required numbers of 33 KV & 11 KV Station Class Surge Arresters shall be provided along with each transformer. The transformers will have mounting facilities for required 33 KV & 11 KV surge arresters.

Surge arresters shall be of the type employing non-linear metal oxide resistors without spark gaps. The contractor shall demonstrate by calculations that the surge arresters will adequately protect the switchgear arrangement.

Surge arresters shall be housed in porcelain insulators designed to withstand extremes of the environment described. The insulation shall have a minimum creepage distance of 25mm/kV rated system phase to phase voltage. Porcelain shall comply with IEC 60233. The method of sealing against the ingress of moisture shall be of a type well proven in service and the manufacturing procedures shall include an effective leak test which can be demonstrated to the inspecting engineer if required.

The internal components of arresters shall be arranged to minimize radial voltage stresses, internal corona and to ensure minimal capacitive coupling with any conducting layer of pollutant on the outside of the porcelain housing.

Good electrical contact shall be maintained between resistor blocks taking account of any thermal expansion and contraction of the block or mechanical shock during transport and erection, by installing a well proven clamping system.

Metal oxide arresters installed outdoors shall be able to dissipate, when new, twice the energy generated in the resistor blocks when energized at their maximum continuous operating voltage immediately having been subjected to the discharge duties specified in IEC 60099-4 and assuming

that the porcelain housing and the surrounding air is at least 5 degree centigrade higher than the maximum ambient air temperature specified.

All surge arresters shall be fitted with a pressure relief diaphragm which shall prevent explosive shattering of the porcelain housing in the event of an arrester failure and the arrester shall have been tested according to the high and low current tests specified in IEC 60099-1. Arresters shall be supplied complete for installation in an outdoor switchyard, including insulating bases and surge counters, one per phase, and, if applicable, grading rings. The material used for terminals shall be compatible with that of the conductors to which they are to be connected.

Each arrester shall be identified by a rating plate in accordance with the requirements of IEC 60099-4. In addition an identification mark shall be permanently inscribed on each separately housed unit of a multi-unit arrester so that units can be replaced in the correct position in the event of them being dismantled.

Surge counters shall have an internal assembly which is matched to the line discharge capability of the arrester and shall include a leakage current meter with a bi-linear scale for ease of reading. Auxiliary contacts are to be provided to signal remote indication of counter **operation**.

Surge arrester shall have suitable earth terminal to connect surge counter with insulated cable.

## Tests

Routine tests and type tests shall be carried out to the specified standards. Bidder shall submit type and routine tests reports of surge arresters along with bid proposal.

The following routine tests shall be carried out on all arrester units in accordance with clause 8.1 of IEC 60099-4.

- Measurement of reference voltage
- Residual voltage test
- Partial discharge test
- Housing leakage test
- Current distribution test for multi-column arrester

## LOSSES AND EVALUATION OF LOSSES

Guaranteed values for component losses of the total loss which shall be as low as is consistent with transport restrictions, reliability and economic use of materials, shall be as stated in the Schedule of Particulars and Guarantees.

For purpose of arriving at comparable prices the iron, copper shall be capitalized on formula given below:  $A = B + 6384 C + 1915 D$

Where A = Evaluated present worth value in US Dollars  
B = Total bid CIF quoted price in US Dollars  
C = Guaranteed Iron Loss in kW  
D = ONAN Guaranteed Copper Loss at 75°C

The acceptance of transformers yielding component losses higher than the guaranteed values shall be governed by- IEC 76 part 1. For actual tested losses higher than guaranteed figures but within acceptable tolerance limits, the bidder will be penalized as follows:

Losses: - USD 6.384 per watt of increased amount of No-load Loss  
- USD 1.915 per watt of increased amount of Load Loss



The maximum acceptable losses at 75 deg. C and at rated voltage, full site rated load and principal tap shall be as stipulated in the following table. Tenderers quoting for transformers with losses exceeding the following figures shall not be evaluated.

| Transformer Rating<br>ONAN | Losses in kW             |                         |
|----------------------------|--------------------------|-------------------------|
|                            | No Load Loss (Iron Loss) | Load Loss (Copper Loss) |
| 10 MVA                     | ≤10                      | ≤57                     |
| 20 MVA                     | ≤12                      | ≤80                     |

NOTE: 1 The no-load offered losses of a transformer shall not exceed the internationally recognized independent laboratory test value by more than 10 % and the total offered losses of a transformer shall not exceed the independent laboratory test value by more than 6%. It is noted that no-load and full-load losses offered by the supplier shall not exceed the losses specified by BREB (mentioned in the clause 34.1 in the specification.)

NOTE-2: Guaranteed loss values must be supported by test reports from internationally recognized independent testing laboratory. In case of difference between the loss value declared in the offer and the loss value to be found in the type test report, the higher loss value will be taken into account for the purpose of loss capitalization.

### Rejection.

The purchaser may reject any transformer, if during evaluation and testing the following is found:

- (a) Load and/or no-load losses exceed the guaranteed value by 15% .
- (b) Total losses exceed the guaranteed values by 10% .
- (c) Impedance differs from the values as specified in clause 16.
- (d) Transformer fails any test.

The Supplier shall supply the replacement transformer and clause 5 shall apply for acceptance of the same.

**FOR OLTC Type 20/28 MVA 33/11.55 KV (ONAN/ONAF) TRANSFORMER**

- a) 20/28 MVA ONAN/ONAF indoor/outdoor mounting, 3-phase, 50 Hz, Dyn1, uniform insulation, 33 kV +4×1.5% and -12×1.5% (HV taps on-load operating), mineral oil immersed, equipped with BCT. The supply of transformer will also include suitable size of MS rail for placing of transformer on foundation.
- b) Normal System Voltage between Phases                      KV      33      11  
      System Frequency                                                      Hz      50      50  
      Rated Voltage between Phase                                      KV      36      12  
      Lightning Impulse withstand                                        KV      170      75  
      50 Hz withstand, 1 minute                                            KV      70      28  
      Symmetrical Short Circuit Current (3sec.)                        KA      31.5      31.5
- c) The three H.T bushing shall be porcelain type being brown glazed. The BCT fitted in the neck of each bushing shall be 20 VA, 600/5A, Class: 5P20
- d) The three L.T bushings, one for each phase and one bushing for the neutral may be of capacitor type or porcelain type with outside glazed of brown porcelain. The BCT fitted in the neck on each phase bushings shall be 20 VA, 1800/5 A, Class: 5P20 and that on the neutral bushing shall be 20 VA, 1800/5 A, Class: 5P20 . In addition to that the "b" phase bushing of the LT side should have a BCT having ratio 1800/5A, 20VA, 5P20 (for WTI), in "a" phase bushing of the LT side should have another BCT having ratio
- 1800/5A, 20 VA, accuracy class .2(Metering CT FS < 5) (for OLTC by auto voltage regulating relay) and in neutral phase bushing should have another BCT having ratio 1800/5A, 20 VA, 5P20 (for Stand by Earth Fault)."
- e) The winding shall be of electrolytic copper, free from burs and splinter. Paper shall be used for conductor insulation. The manufacturer must provide the thermal damage curve or thermal damage description of the transformer winding or the transformer as per relevant IEC standard
- f) The insulating oil shall meet all requirements as defined by NEMA standard/BS shall be chemically stable, free from acidity and other corrosive ingredients and shall possess high dielectric strength oil for first filling shall be shipped in non-returnable drums. 10% of the quantity required for a transformer is to be supplied in addition in respect of each transformer due to usual losses during installation, centrifuging, etc.
- g) The transformer tank shall be of welded construction, fabricated from high tensile steel plate and shall be designed so that the tank is to withstand vacuum up to 500mm of mercury for 10 MVA and 20 MVA transformers and any pressure of oil developed during operation conditions including short circuits.
- h) The transformer shall have air seal conventional type oil conservator tank (the oil surface is completely isolated from the atmosphere by installing an oil resistant rubber seal in the interior of the conservator) at the top divided into two halves internally: one part to be connected with transformer main tank through Buchholz Relay (with cocks on both side) and the other part with OLTC tank through another gas Relay (with cock either side). Both the halves will have oil level indicator (visual) with contacts for indication "LOW OIL LEVEL" in the control panel.
- i) Pressure Release Devices for both main tank and OLTC Tank shall be provided.
- j) Silica Gel Breather with glass window shall be provided for both halves of the conservator tank.
- k) The on-load Tap Changer operating device shall be equipped with local (manual and electrical) and remote electrical operating device with appropriate interlocking. The OLTC motor shall be 3-phase 400 V operating type. The mechanical position indication shall be there both at the tap changer as well as on the operating device. Contacts/Arrangements shall be there for remote position indication (by lamp glowing) of the tap. Appropriate glands for the entry of control cable shall be provided.

- l) Sufficient cooling Fans (3-phase, 415V, 50 Hz) of adequate capacity shall be fitted on the body of the transformer for cooling purpose to achieve the ONAF rating over the average ambient temperature of 40 degree C. There shall be a control device in weather proof housing fitted on the body of the transformer and equipped with control relay operated by sensing device of oil temperature inside the transformer and operate requisite no. of fans. Besides there shall be manual switching device of cooling fans.
- m) The Radiators shall be in banks which can be fitted with or removed from the body of transformer tank. Sufficient radiators shall be provided to achieve the ONAN rating at average ambient temperature of 40 degree C. Each bank of radiator must have two stop valve one of which should be fixed at the top and the other at the bottom.
- n) Besides the main components of the transformer the other features and accessories to be associated which are as follows:
  - i) Inspection hole with cover.
  - ii) Manhole.
  - iii) Name plate with complete diagrams and main specifications.
  - iv) Upper and lower oil valves, oil sampling valve and drain valve.
  - v) Ladder to climb up to top with barrier at the bottom.
  - vi) Thermometer for sensing oil and winding temperature and display.
  - vii) All HV (33 KV) terminals shall be provided with appropriate connecting clamps to be connected with 400 mm<sup>2</sup> cables. The LV (11 KV) terminals shall have also connecting clamps appropriate for being connected with on 4×300 mm<sup>2</sup> cables. The neutral terminal shall have connecting clamps to be connected with 2/0 HDBS wire.
  - viii) There shall be four wheels (flanged type) suitable for mounting on rails and to carry the transformer as a whole.
  - ix) The transformer shall have at least two grounding terminals on its body.

All ferrous parts of the transformer shall be galvanized or painted with appropriate paints of MUNSELL NO-5y 7/1 transformer with maximum shipping height (not exceeding 11 feet) will be preferred.

- o) One set of extra gaskets for each transformer is to be supplied with the transformer lot without extra cost.

#### **FOR OLTC TYPE 10/14 MVA 33/11.55 KV (ONAN/ONAF) TRANSFORMER**

- a) 10/14 MVA ONAN/ONAF indoor/outdoor mounting, 3-phase, 50 Hz, Dyn1, uniform insulation, 33 kV +4×1.5% and -12×1.5% (HV taps on-load operating), mineral oil immersed, equipped with BCT. The supply of transformer will also include suitable size of MS rail for placing of transformer on foundation.

|                                           |    |      |      |
|-------------------------------------------|----|------|------|
| b) Normal System Voltage between Phases   | KV | 33   | 11   |
| System Frequency                          | Hz | 50   | 50   |
| Rated Voltage between Phase               | KV | 36   | 12   |
| Lightning Impulse withstand               | KV | 170  | 75   |
| 50 Hz withstand, 1 minute                 | KV | 70   | 28   |
| Symmetrical Short Circuit Current (3sec.) | KA | 31.5 | 31.5 |

- c) The three H.T bushing shall be porcelain type being brown glazed. The BCT fitted in the neck of each bushing shall be 20VA, 400/5A (for 10 MVA) Class: 5P20
- d) The three L.T bushings, one for each phase and one bushing for the neutral may be of capacitor type or porcelain type with outside glazed of brown porcelain. The BCT fitted in the neck on each phase bushings shall be 20 VA, 1200/5 A, Class: 5P20 and that on the neutral bushing shall be 20 VA, 1200/5 A, Class: 5P20. In addition to that the "b" phase bushing of the LT side should have a BCT having ratio 1200/5A, 20 VA, 5P20 (for WTI), in "a" phase bushing of the LT side should have another BCT having ratio 1200/5A, 20 VA, accuracy class .2 (Metering CT FS < 5) (for OLTC by auto voltage regulating relay) and in neutral phase bushing should have another BCT having ratio 1200/5A, 20 VA, 5P20 (for Stand by Earth Fault)."
- e) The winding shall be of electrolytic copper, free from burs and splinter. Paper shall be used for conductor insulation.

The manufacturer must provide the thermal damage curve or thermal damage description of the transformer winding or the transformer as per relevant IEC standard

- f) The insulating oil shall meet all requirements as defined by NEMA standard/BS shall be chemically stable, free from acidity and other corrosive ingredients and shall possess high dielectric strength oil for first filling shall be shipped in non-returnable drums. 10% of the quantity required for a transformer is to be supplied in addition in respect of each transformer due to usual losses during installation, centrifuging, etc.
- g) The transformer tank shall be of welded construction, fabricated from high tensile steel plate and shall be designed to withstand 500 mm of mercury.
- h) The transformer shall have air seal conventional type oil conservator tank (the oil surface is completely isolated from the atmosphere by installing an oil resistant rubber seal in the interior of the conservator) at the top divided into two halves internally: one part to be connected with transformer main tank through Buchholz Relay (with cocks on both side) and the other part with OLTC tank through another gas Relay (with cock either side). Both the halves will have oil level indicator (visual) with contacts for indication "LOW OIL LEVEL" in the control panel.
  - i) Pressure Release Devices for both main tank and OLTC Tank shall be provided.
  - j) Silica Gel Breather with glass window shall be provided for both halves of the conservator tank.
- k) The on-load Tap Changer operating device shall be equipped with local (manual and electrical) and remote electrical operating device with appropriate interlocking. The OLTC motor shall be 3-phase 400 V operating type. The mechanical position indication shall be there both at the tap changer as well as on the operating device. Contacts/Arrangements shall be there for remote position indication (by lamp glowing) of the tap. Appropriate glands for the entry of control cable shall be provided.
- l) Sufficient cooling Fans (3-phase, 415V, 50 Hz) of adequate capacity shall be fitted on the body of the transformer for cooling purpose to achieve the ONAF rating over the average ambient temperature of 40 degree C. There shall be a control device in weather proof housing fitted on the body of the transformer and equipped with control relay operated by sensing device of oil temperature inside the transformer and operate requisite no. of fans. Besides there shall be manual switching device of cooling fans.
- m) The Radiators shall be in banks which can be fitted with or removed from the body of transformer tank. Sufficient radiators shall be provided to achieve the ONAN rating at average ambient temperature of 40 degree C. Each bank of radiator must have two stop valve one of which should be fixed at the top and the other at the bottom.
- n) Besides the main components of the transformer the other features and accessories to be associated which are as follows:
  - i) Inspection hole with cover.
  - ii) Manhole.
  - iii) Name plate with complete diagrams and main specifications.
  - iv) Upper and lower oil valves, oil sampling valve and drain valve.
  - v) Ladder to climb up to top with barrier at the bottom.
  - vi) Thermometer for sensing oil and winding temperature and display.
  - vii) All HV (33 KV) terminals shall be provided with appropriate connecting clamps to be connected with 185mm<sup>2</sup> cables. The LV (11 KV) terminals shall have also connecting clamps appropriate for being connected with on 3×185 mm<sup>2</sup> cables. The neutral terminal shall have connecting clamps to be connected with 2/0 HDBS wire
  - viii) There shall be four wheels (flanged type) suitable for mounting on rails and to carry the transformer as a whole
  - ix) The transformer shall have at least two grounding terminals on its body.

All ferrous parts of the transformer shall be galvanized or painted with appropriate paints of MUNSELL NO-5y 7/1 transformer with maximum shipping height (not exceeding 11 feet) will be preferred.

**WARRANTY**

The bidder shall warrant that the transformers furnished have conformed to this specification. The warranty shall state that if, within three (3) years from the date transformers are delivered , a transformer is found to have defects in workmanship or material or fails in service , the Contractor shall repair or replace such defective parts (and other parts damaged as a result) within 15 days with free of charge .

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

**For OLTC Type 20/28 MVA 33/11.55 K, 50 Hz TRANSFORMERS**

(To be filled up by the supplier with appropriate data, otherwise the Tender will be rejected)

| Description                                                                 | Unit    | REB Requirement | Tenderers Guaranteed Values |
|-----------------------------------------------------------------------------|---------|-----------------|-----------------------------|
| <b>33/11.55 kV TRANSFORMERS</b>                                             |         |                 |                             |
| 1. Manufacturer's Name                                                      |         |                 | _____                       |
| 2. Manufacturer's Address                                                   |         |                 | _____                       |
| 3. Applied Standard                                                         |         |                 | _____                       |
| 4. Type                                                                     |         | Outdoor         | _____                       |
| 5. Rated Power                                                              | MVA     | ONAN/ONAF       | _____                       |
|                                                                             |         | 20/28 MVA       | _____                       |
| 6. Number of Phase                                                          |         | Three Phase     | _____                       |
| 7. Rated Voltage, Phase to Phase                                            |         |                 |                             |
| High Voltage winding                                                        | kV      | 33              | _____                       |
| Low Voltage winding                                                         | kV      | 11.55           | _____                       |
| 8. Rated frequency                                                          | Hz      | 50              | _____                       |
| 9. Rated insulation level                                                   |         |                 |                             |
| (a) Impulse withstand, full wave                                            |         |                 |                             |
| High voltage winding                                                        | kV      | 170             | _____                       |
| Low voltage winding                                                         | kV      | 75              | _____                       |
| Neutral side                                                                |         | Full insulation | _____                       |
| (b) AC withstand voltage                                                    |         |                 |                             |
| High voltage winding                                                        | kV      | 70              | _____                       |
| Low voltage winding                                                         | kV      | 28              | _____                       |
| 10. Vector Diagram (IEC 76-4)                                               |         | Dyn1            | _____                       |
| 11. Type of Cooling, 20/28 MVA                                              |         | ONAN/ONAF       | _____                       |
| 12. On load Tap- changer ('MR' Germany/ABB, Sweden/ Hitachi Energy, Sweden) |         |                 |                             |
| Type                                                                        |         |                 |                             |
| Rated                                                                       | kV      | 33              | _____                       |
| tap Tap                                                                     | %       | + 6 to -18      | _____                       |
| range                                                                       | Amps    | Required        | _____                       |
| Capacity                                                                    |         |                 |                             |
| Numbers of tap                                                              | Taps    | 17 Nos          | _____                       |
| Location of tap                                                             |         | Primary         | _____                       |
| Rated short time current                                                    | kV      | side            | _____                       |
| Oil volume                                                                  | Liter   |                 | _____                       |
| Duration of one step change                                                 | sec     |                 | _____                       |
| Motor rating                                                                | kW      |                 | _____                       |
| 13. Impedance voltage at 75°C and at nominal ratio and 100% rated power     |         |                 |                             |
| (a) 20 MVA                                                                  | %       | 10.0% (with     | _____                       |
|                                                                             |         | +10%            | _____                       |
|                                                                             |         | tolerance)      | _____                       |
| 14. Temperature rise at rated power (Max. ambient temperature: 40°C)        | deg. C. | 55              | _____                       |
| Oil by thermometer                                                          |         |                 | _____                       |
| Winding by resistance measurement                                           | deg. C. | 60              | _____                       |
| overload not to exceed                                                      |         |                 |                             |
| 14b. Maximum hot spot temperature when loaded in accordance with IEC 354    | Deg. C  | 118             | _____                       |
| 15. System symmetrical fault level at terminal of                           |         |                 |                             |
| 33 kV                                                                       | kA      | 31.5            | _____                       |
| 11 kV                                                                       | kA      | 31.5            | _____                       |
| 15a. Duration of symmetrical short circuit current                          | Sec     | 2               | _____                       |
| for which the transformer is to be designed                                 |         |                 |                             |

(calculation as per IEC is to be furnished)

|                                                                    |       |            |  |  |
|--------------------------------------------------------------------|-------|------------|--|--|
| 16. Transformer core                                               |       |            |  |  |
| Type of core flux density                                          |       |            |  |  |
| At nominal voltage                                                 | Tesla | ≤1.6       |  |  |
| 17. Transformer bushings                                           |       |            |  |  |
| (a) H.V. Bushing                                                   |       |            |  |  |
| Voltage class                                                      |       |            |  |  |
| Cantilever strength                                                |       |            |  |  |
| (b) L.V. Bushing                                                   |       |            |  |  |
| Voltage class                                                      |       |            |  |  |
| Cantilever strength                                                |       |            |  |  |
| (c) Neutral Bushing                                                |       |            |  |  |
| Voltage class                                                      |       |            |  |  |
| Cantilever strength                                                |       |            |  |  |
| 18. Conservator                                                    |       |            |  |  |
| 19. Auxiliary circuit voltage for fan, etc, 3P-4W                  | V     | 415/240 AC |  |  |
| 20. Control Voltage                                                | V     | 110 DC     |  |  |
| 21. Sound level (IEC 551)                                          |       |            |  |  |
| ONAN                                                               | dB    | 65         |  |  |
| ONAF                                                               | dB    | 80         |  |  |
| 22. Transformer Bushing CT                                         |       |            |  |  |
| <u>HV Side</u>                                                     |       |            |  |  |
| On phase "a, b &c" (Differential)                                  |       |            |  |  |
| - Current Ratio                                                    | A     | 600/5      |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class X    |  |  |
| - Short time current                                               | kA    |            |  |  |
| <u>LV side</u>                                                     |       |            |  |  |
| On phase "a, b &c" (Differential)                                  |       |            |  |  |
| - Current Ratio                                                    | A     | 1800/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class X    |  |  |
| - Short time current                                               | kA    |            |  |  |
| On phase "a" (OLTC)                                                |       |            |  |  |
| - Current Ratio                                                    | A     | 1800/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| - Short time current                                               | kA    |            |  |  |
| On phase "b" (WTI)                                                 |       |            |  |  |
| - Current Ratio                                                    | A     | 1800/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| - Short time current                                               | kA    |            |  |  |
| Neutral Bushing for REF:                                           |       |            |  |  |
| - Current Ratio                                                    | A     | 1800/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class X    |  |  |
| - Short time current                                               | kA    |            |  |  |
| Neutral Bushing CT for stand by earth fault                        |       |            |  |  |
| - Current Ratio                                                    | A     | 1800/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| - Short time current                                               | kA    |            |  |  |
| 23. Number of Cooling fan                                          | Nos.  |            |  |  |
| 24. Rating of Fan motors                                           | kW    |            |  |  |
| 25. Cooling fan losses at full ONAN capacity operation             | kW    |            |  |  |
| 26. Core Loss at rated frequency and rated voltage at nominal tap. | kW    |            |  |  |



|                                                                                                                                       |                   |                                                         |  |
|---------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------------------------------------------------|--|
| 27. Copper Loss at full load, at rated frequency                                                                                      |                   |                                                         |  |
| (i) At ONAN                                                                                                                           |                   |                                                         |  |
| (a) At Maximum Tap                                                                                                                    | kW                |                                                         |  |
| (b) At Nominal Tap                                                                                                                    | kW                |                                                         |  |
| (c) At Minimum Tap                                                                                                                    | kW                |                                                         |  |
| At ONAF                                                                                                                               |                   |                                                         |  |
| (a) At Maximum Tap                                                                                                                    | kW                |                                                         |  |
| (b) At Nominal Tap                                                                                                                    | kW                |                                                         |  |
| (c) At Minimum Tap                                                                                                                    | kW                |                                                         |  |
| 28. Exciting Current at nominal tap and rated voltage                                                                                 | A                 |                                                         |  |
| 29. Dimensions and Weight                                                                                                             |                   |                                                         |  |
| Maximum size for transport                                                                                                            |                   |                                                         |  |
| L x W x H                                                                                                                             | mm                |                                                         |  |
| Heaviest weight for transport                                                                                                         | Kg                |                                                         |  |
| Overall height                                                                                                                        | mm                |                                                         |  |
| Oil volume                                                                                                                            | Liter             |                                                         |  |
| Weight of oil                                                                                                                         | Kg                |                                                         |  |
| Weight of core                                                                                                                        | Kg                |                                                         |  |
| Total weight                                                                                                                          | Kg                |                                                         |  |
| 30. Oil level indicator                                                                                                               |                   |                                                         |  |
| Type and model                                                                                                                        |                   |                                                         |  |
| 31. Pressure Relief Device                                                                                                            |                   |                                                         |  |
| Type and model                                                                                                                        |                   |                                                         |  |
| 32. Buchholz Relay                                                                                                                    |                   |                                                         |  |
| Type and model                                                                                                                        |                   |                                                         |  |
| Float Type                                                                                                                            | Solid Body        |                                                         |  |
| Petcock is provided for testing by injecting air                                                                                      | Yes               |                                                         |  |
| Pipe arrangement for gas release and oil collection from ground level                                                                 | Yes               |                                                         |  |
| Oil surge protection                                                                                                                  | Yes               |                                                         |  |
| Oil drain screw provided                                                                                                              | Yes               |                                                         |  |
| 33. Oil & Winding temperature indicator                                                                                               |                   |                                                         |  |
| Type & model                                                                                                                          |                   |                                                         |  |
| 34 Efficiency at 75° C at unity power factor:                                                                                         |                   |                                                         |  |
| a) At 28 MVA load                                                                                                                     | %                 |                                                         |  |
| b) At 20 MVA load                                                                                                                     | %                 |                                                         |  |
| c) At 15 MVA load                                                                                                                     | %                 |                                                         |  |
| d) At 10 MVA load                                                                                                                     | %                 |                                                         |  |
| 34. Transformer tank                                                                                                                  |                   |                                                         |  |
|                                                                                                                                       | Shall be provided | Shall be high tensile steel plate                       |  |
| 35 .Pressure release device for both main and OLTC Tank                                                                               |                   |                                                         |  |
|                                                                                                                                       | Shall be provided | Shall be provided                                       |  |
| 36. Winding shall be of electrolytic copper.                                                                                          |                   |                                                         |  |
|                                                                                                                                       | Shall be provided | Shall be Electrolytic copper                            |  |
| 37. Pressure release device, Temperature indicating device and Buchholz relay shall be from MR Germany or Equivalent European Origin. |                   |                                                         |  |
|                                                                                                                                       | To be provided    | Shall be from MR Germany or Equivalent European Origin. |  |

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****OLTC Type 33/11.55 kV 10/14MVA POWER TRANSFORMERS**

**(If the Answer to the 'Deviation Column' is 'YES'. Then an explanation shall be provided in the schedule of deviations)**

**Failure to provide all of the information requested may lead to the rejection of the bid.**

| Description                                                                                                        | Unit                       | REB Requirement                       | Bidders Guaranteed Values | Deviation Yes/No |
|--------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------------|---------------------------|------------------|
| 1. Manufacturer's Name                                                                                             |                            | Required                              |                           |                  |
| 2. Manufacturer's Address                                                                                          |                            | Required                              |                           |                  |
| 3. Applied Standard                                                                                                |                            | Required                              |                           |                  |
| 4. Type                                                                                                            |                            | Outdoor Oil immersed                  |                           |                  |
| 5. (a) Rated Power                                                                                                 | MVA                        | ONAN/ONAF<br>10/14 MVA<br>Three Phase |                           |                  |
| (b) Overload Capability                                                                                            |                            | In accordance with IEC 603564         |                           |                  |
| 6. Number of Phase                                                                                                 |                            | Three                                 |                           |                  |
| 7. Rated Voltage, Phase to Phase                                                                                   |                            | Required                              |                           |                  |
| High Voltage winding                                                                                               | kV                         | 33                                    |                           |                  |
| Low Voltage winding                                                                                                | kV                         | 11.55                                 |                           |                  |
| 8. Rated frequency                                                                                                 | Hz                         | 50                                    |                           |                  |
| 9. Rated insulation level                                                                                          |                            | Required                              |                           |                  |
| a) Impulse withstand, full wave                                                                                    |                            |                                       |                           |                  |
| High voltage winding                                                                                               | kV                         | 170                                   |                           |                  |
| Low voltage winding                                                                                                | kV                         | 75                                    |                           |                  |
| Neutral side                                                                                                       |                            | Full insulation                       |                           |                  |
| (b) AC withstand voltage                                                                                           |                            |                                       |                           |                  |
| High voltage winding                                                                                               | kV                         | 70                                    |                           |                  |
| Low voltage winding                                                                                                | kV                         | 28                                    |                           |                  |
| 10. Vector Diagram (IEC 76-4)                                                                                      | Dyn1                       | Required                              |                           |                  |
| 11. Type of Cooling, 10/14 MVA                                                                                     | ONAN / ONAF                | Required                              |                           |                  |
| 12. On load Tap – changer ('MR' Germany/ABB, Sweden/Hitachi Energy, Sweden)                                        |                            | Required                              |                           |                  |
| Type                                                                                                               |                            | Required                              |                           |                  |
| Rated Capacity                                                                                                     | In Amps                    | Required                              |                           |                  |
| Rated tap                                                                                                          | kV                         | 33                                    |                           |                  |
| Tap range                                                                                                          | %                          | - 18 to +6                            |                           |                  |
| Numbers of tap                                                                                                     | Taps                       | 17                                    |                           |                  |
| Tap step                                                                                                           | %                          | 1.5                                   |                           |                  |
| Location of tap                                                                                                    |                            | Primary side                          |                           |                  |
| Rated short time current                                                                                           | kA                         | Required                              |                           |                  |
| Oil volume                                                                                                         | Litre                      | Required                              |                           |                  |
| Duration of one step change                                                                                        | sec                        | Required                              |                           |                  |
| Motor rating                                                                                                       | kW                         | Required                              |                           |                  |
| 13. Impedance voltage at 75° C and at nominal ratio and 100% rated power at principal tap (with tolerance of +10%) | 8.0% (with +10% tolerance) | Required                              |                           |                  |
| 14. Temperature rise at rated power (Max. ambient temperature: 40° C)                                              |                            | Required                              |                           |                  |
| Oil by thermometer                                                                                                 | deg. C.                    | 55                                    |                           |                  |
| Winding by resistance measurement.                                                                                 | deg. C.                    | 60                                    |                           |                  |
| 16. Transformer core: Type of core, max. flux density At nominal voltage                                           | Tesla                      | ≤1.6                                  |                           |                  |



|                                                                    |       |            |  |  |
|--------------------------------------------------------------------|-------|------------|--|--|
| 17. Transformer bushings shall be from Europe/America/Japan origin |       |            |  |  |
| (a) H.V. Bushing                                                   |       |            |  |  |
| Voltage class                                                      |       | Required   |  |  |
| Cantilever strength                                                |       | Required   |  |  |
| Transformer bushing HV CT                                          |       | Required   |  |  |
| - Current Ratio                                                    | A     | 400/5      |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| 18. Conservator                                                    |       | Required   |  |  |
| 19. Auxiliary circuit voltage for fan, etc, 3phase – 4 wire        | V     | 415/240 AC |  |  |
| 20. Control Voltage                                                | V     | 110 DC     |  |  |
| 21. Sound level (IEC 60551)                                        |       |            |  |  |
| ONAN (0.3m)                                                        | dB    | Required   |  |  |
| ONAF (2 m)                                                         | dB    | <80        |  |  |
| 22. Transformer Bushing LV CT                                      |       |            |  |  |
| On phase (OLTC)                                                    |       |            |  |  |
| - Current Ratio                                                    | A     | 1200/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| - Short time current                                               | kA    | Required   |  |  |
| On phase "b" (WTI)                                                 |       |            |  |  |
| - Current Ratio                                                    | A     | 1200/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| - Short time current                                               | kA    | Required   |  |  |
| Neutral Bushing CT for REF :                                       |       |            |  |  |
| - Current Ratio                                                    | A     | 1200/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| Neutral Bushing CT for stand by earth fault                        |       |            |  |  |
| - Current Ratio                                                    | A     | 1200/5     |  |  |
| - Rated burden                                                     | VA    | 20         |  |  |
| - Accuracy                                                         |       | Class 5P20 |  |  |
| - Short time current                                               | kA    | Required   |  |  |
| 23. Number of Cooling fan                                          | Nos.  | Required   |  |  |
| 24. Rating of Fan motors                                           | kW    | Required   |  |  |
| 25. Cooling fan losses at full ONAF capacity operation             | kW    | Required   |  |  |
| 26. Core Loss at rated frequency and rated voltage at nominal tap. | kW    | Required   |  |  |
| 27. Copper Loss at full load, at rated                             |       | Required   |  |  |
| frequency and at 75 °C                                             |       | Required   |  |  |
| (a) At Maximum Tap                                                 | kW    | Required   |  |  |
| (b) At Nominal Tap                                                 | kW    | Required   |  |  |
| (c) At Minimum Tap                                                 | kW    | Required   |  |  |
| 28. Exciting Current at nominal tap and rated voltage.             | A     | Required   |  |  |
| 29. Dimensions and Weight                                          |       | Required   |  |  |
| Maximum size for transport L x W x H                               | mm    | Required   |  |  |
| Heaviest weight for transport                                      | Kg    | Required   |  |  |
| Overall height                                                     | mm    | Required   |  |  |
| Oil volume                                                         | Litre | Required   |  |  |
| Weight of oil                                                      | Kg    | Required   |  |  |
| Weight of core                                                     | Kg    | Required   |  |  |

|                                                                                                                                           |                   |                                                         |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------------------------------------------------|--|--|
| Total weight                                                                                                                              | Kg                | Required                                                |  |  |
| Dimensions and Weight                                                                                                                     |                   | Required                                                |  |  |
| Transformer tank                                                                                                                          | Shall be provided | Shall be high tensile steel plate                       |  |  |
| Pressure release device for both main and OLTC Tank                                                                                       | Shall be provided | Shall be provided                                       |  |  |
| Winding shall be of electrolytic copper.                                                                                                  | Shall be provided | Shall be Electrolytic copper                            |  |  |
| Pressure release device, Temperature indicating device and Buchholz relay shall be from MR Germany or Equivalent European Origin.         | To be provided    | Shall be from MR Germany or Equivalent European Origin. |  |  |
| 30. Duration of symmetrical short circuit current for which the transformer is to be designed (calculation as per IEC is to be furnished) | Sec               | 2                                                       |  |  |

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****33 kV SURGE ARRESTER, Station Class**

(If the Answer to the 'Deviation Column' is 'YES'. Then an explanation shall be provided in the schedule of deviations)

Failure to provide all of the information requested may lead to the rejection of the bid.

| SI No                       | Description                                                             | Unit | REB Requirement                                    | Bidders Guaranteed Values | Deviation Yes/No |
|-----------------------------|-------------------------------------------------------------------------|------|----------------------------------------------------|---------------------------|------------------|
| <b>33 KV SURGE ARRESTER</b> |                                                                         |      |                                                    |                           |                  |
| 1.                          | Manufacturer's Name & Address                                           |      | Required                                           |                           |                  |
| 2.                          | Class of diverter to IEC 99-4                                           |      | Heavy duty, ZnO                                    |                           |                  |
| 3.                          | Rated voltage (RMS)                                                     | kV   | 30                                                 |                           |                  |
| 4.                          | Rated current                                                           | kA   | 10                                                 |                           |                  |
| 5.                          | Neutral connection                                                      |      | Effectively earthed                                |                           |                  |
| 6.                          | Power frequency withstand voltage of housing:                           |      |                                                    |                           |                  |
|                             | Dry :                                                                   | kV   | 70 (RMS)                                           |                           |                  |
|                             | Impulse:                                                                | kV   | 170                                                |                           |                  |
| 7.                          | Lighting impulse residual voltage                                       | kV   | 100 peak                                           |                           |                  |
| 8.                          | Steep current impulse residual voltage at 10 kA or 1 $\mu$ S front time | kV   | 110                                                |                           |                  |
| 9.                          | Pressure relief device fitted?                                          | Y/N  | Required                                           |                           |                  |
| 10.                         | Leakage current at rated voltage                                        | A    | Required                                           |                           |                  |
| 11.                         | Minimum reset voltage                                                   | V    | Required                                           |                           |                  |
| 12.                         | Total creepage distance                                                 | mm   | Required                                           |                           |                  |
| 13.                         | Surge monitor                                                           |      | Required                                           |                           |                  |
| 14.                         | Connecting Lead from LA terminal to surge monitor:                      |      | Shall be Insulated 16 mm <sup>2</sup> copper cable |                           |                  |
| 15.                         | Overall dimension and Weight :                                          |      |                                                    |                           |                  |
|                             | Height                                                                  | mm   | Required                                           |                           |                  |
|                             | Diameter                                                                | mm   | Required                                           |                           |                  |
|                             | Total weight of arrester                                                | Kg.  | Required                                           |                           |                  |
|                             | Height                                                                  | mm   | Required                                           |                           |                  |

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE  
11 kV SURGE ARRESTER, Station Class**

(If the Answer to the 'Deviation Column' is 'YES'. Then an explanation shall be provided in the schedule of deviations) Failure to provide all of the information requested may lead to the rejection of the bid.

| SI No                       | Description                                                             | Unit | REB Requirement                                    | Bidders Guaranteed Values | Deviation Yes/No |
|-----------------------------|-------------------------------------------------------------------------|------|----------------------------------------------------|---------------------------|------------------|
| <b>11 KV SURGE ARRESTER</b> |                                                                         |      |                                                    |                           |                  |
| 1.                          | Manufacturer's Name & Address                                           |      | Required                                           |                           |                  |
| 2.                          | Class of diverter to IEC 99-4                                           |      | Heavy duty, ZnO                                    |                           |                  |
| 3.                          | Rated voltage (RMS)                                                     | kV   | 10                                                 |                           |                  |
| 4.                          | Rated current                                                           | kA   | 10                                                 |                           |                  |
| 5.                          | Neutral connection                                                      |      | Effectively earthed                                |                           |                  |
| 6.                          | Power frequency withstand voltage of housing:                           |      | Required                                           |                           |                  |
|                             | Dry :                                                                   | kV   | 28(RMS)                                            |                           |                  |
|                             | Impulse:                                                                | kV   | 70                                                 |                           |                  |
| 7.                          | Lighting impulse residual voltage                                       | kV   | Required                                           |                           |                  |
| 8.                          | Steep current impulse residual voltage at 10 kA or 1 $\mu$ S front time | kV   | Required                                           |                           |                  |
| 9.                          | Pressure relief device fitted?                                          | Y/N  | Required                                           |                           |                  |
| 10.                         | Leakage current at rated voltage                                        | A    | Required                                           |                           |                  |
| 11.                         | Minimum reset voltage                                                   | V    | Required                                           |                           |                  |
| 12.                         | Total creepage distance                                                 | mm   | Required                                           |                           |                  |
| 13.                         | Surge monitor                                                           |      | To be provided                                     |                           |                  |
| 14.                         | Connecting Lead from LA terminal to surge monitor:                      |      | Shall be Insulated 16 mm <sup>2</sup> copper cable |                           |                  |
| 15.                         | Overall dimension and Weight :                                          |      |                                                    |                           |                  |
|                             | Height                                                                  | mm   | Required                                           |                           |                  |
|                             | Diameter                                                                | mm   | Required                                           |                           |                  |
|                             | Total weight of arrester                                                | Kg.  | Required                                           |                           |                  |
|                             | Height                                                                  | mm   | Required                                           |                           |                  |

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE  
33/0.433 kV, 3 Phase 200 KVA STATION TRANSFORMER**

**(If the Answer to the 'Deviation Column' is 'YES'. Then an explanation shall be provided in the schedule of deviations) Failure to provide all of the information requested may lead to the rejection of the bid.**

| Description                                                         | Unit   | REB Requirement | Bidders Guaranteed Values | Deviation Yes/No |
|---------------------------------------------------------------------|--------|-----------------|---------------------------|------------------|
| <b>STATION SERVICE TRANSFORMERS</b>                                 |        |                 |                           |                  |
| 1. Manufacturer's Name                                              |        | Required        |                           |                  |
| 2. Manufacturer's Address                                           |        | Required        |                           |                  |
| 3. Type                                                             |        | Required        |                           |                  |
| 4. Applicable Standard                                              |        | Required        |                           |                  |
| 5. Rated power                                                      | kVA    | 200             |                           |                  |
| 6. Rated voltage :                                                  |        |                 |                           |                  |
| - High voltage winding                                              | kV     | 33              |                           |                  |
| - Low voltage winding                                               | V      | 433 / 250       |                           |                  |
| 7. Vector diagram                                                   |        | Dyn 11          |                           |                  |
| 8. Rated Frequency                                                  | Hz     | 50              |                           |                  |
| 9. Type of cooling                                                  |        | ONAN            |                           |                  |
| 10. Type of bushing :                                               |        |                 |                           |                  |
| - High voltage                                                      |        | Required        |                           |                  |
| - Low voltage                                                       |        | Required        |                           |                  |
| 11. Off load tap-changer :                                          |        |                 |                           |                  |
| - Rated tap                                                         | kV     | 33              |                           |                  |
| - Tap range                                                         | %      | + 5 to – 5      |                           |                  |
| - Number of taps                                                    | Taps   | 5               |                           |                  |
| 12. Impedance voltage at 75deg C., at nominal ratio and rated power | %      | 4%±10%          |                           |                  |
| Temperature rise at rated power                                     |        | Required        |                           |                  |
| (Max. ambient temp.: 40° C)                                         |        | Required        |                           |                  |
| 13. - Oil by thermometer                                            | deg. C | 55              |                           |                  |
| 14. Winding by resistance measurement                               | deg. C | 60              |                           |                  |



|                                                                    |    |          |  |  |
|--------------------------------------------------------------------|----|----------|--|--|
| 15. Dimensions and Total Weight                                    |    | Required |  |  |
| 16. Height x width x depth                                         | mm | Required |  |  |
| 17. Total weight                                                   | Kg | Required |  |  |
| 18. Dimensions and Total Weight                                    |    | Required |  |  |
| 19. Core Loss at rated frequency and rated voltage at nominal tap. | kW | Required |  |  |
| 20. Copper Loss at full load, at rated frequency and at 75 °C      |    |          |  |  |
| (a) At Maximum Tap                                                 | kW | Required |  |  |
| (b) At Nominal Tap                                                 | kW | Required |  |  |
| (c) At Minimum Tap                                                 | kW | Required |  |  |

### 1.13 Design requirements for GIS/AIS equipment Technical Specification for 33kV Gas Insulated Switchgear Scope

The scope of this specification is to provide the technical requirements for the design, manufacturing, inspection, factory tests, packing, shipping, delivery to site, installation and commissioning for 33 kV Gas Insulated Switchgear for 33/11 kV substation to be used in BREB distribution system and shall be read in conjunction with the Project Requirements, Schedules and Drawings in the specification.

The Contractor shall demonstrate that the GIS has been designed, built and installed in accordance with the relevant international standards and the specification. It shall also operate and perform on a site in accordance with the requirements of the specification and in the environment defined herein. The design shall be proven by the submission at the time of Tender of test certificates covering all specified tests deemed to be pertinent to the plant and to the conditions in which it will operate or, if such test certificates cannot be supplied or are deemed unacceptable by the Employer, type tests which will be subject to the conditions of this Contract shall be carried out at no extra cost to the Employer. The requirement for switchgear spares, tools and appliances, including test, maintenance and handling equipment shall be as per mentioned in this Tender document. All devices necessary for operation and earthing shall be provided within the Contract Price.

The requirements contained in this document shall in no way be interpreted as limiting in respect of the quality of design and features and construction technologies; their compliance shall not relieve the Contractor from the responsibility to provide equipment and accessories properly designed and adapted to the requested service.

### Reference Standards

The last edition of the standards mentioned in Table 1 that shall be taken in consideration.

| Standard                                     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IEC 62271-1,100,102,103,200,201,203,206, 307 | High-voltage switchgear and control gear:<br>Part 1: Common specifications<br>Part 100: Alternating current circuit-breakers<br>Part 102: Alternating current dis connectors and earthing switches<br>Part 103: Switches for rated voltages above 1 kV up to and including 52 kV<br>Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV<br>Part 201: AC solid-insulation enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV<br>Part 203: Gas insulated metal-enclosed switchgear for rated voltages above 52 kV<br>Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV<br>Part 307: Guidance for the extension of validity of type tests of AC metal and solid-insulation enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV |
| IEC 60947-2                                  | Low-voltage switchgear and controlgear – Part 2: Circuit-breakers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| IEC 60947-5-1                                | Low-voltage switchgear and control gear – Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IEC 61869-1,2,6,9,10,11 | Instrument transformers<br>Part 1: General requirements<br>Part 2: Additional requirements for current transformers<br>Part 6: Additional general requirements for low-power instrument transformers<br>Part 9: Digital interface for instrument transformers<br>Part 10: Additional requirements for low-power passive current transformers<br>Part 11: Additional requirements for low power passive voltage transformers |
| IEC 60255               | Measuring relays and protection equipment                                                                                                                                                                                                                                                                                                                                                                                   |
| IEC 60073               | Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators                                                                                                                                                                                                                                                                                          |
| IEC 60352               | Solderless connections                                                                                                                                                                                                                                                                                                                                                                                                      |
| IEC 60529               | Degrees of protection provided by enclosures (IP Code)                                                                                                                                                                                                                                                                                                                                                                      |
| IEC 61000               | Electromagnetic compatibility (EMC)                                                                                                                                                                                                                                                                                                                                                                                         |
| IEC 60270               | High-voltage test techniques - Partial discharge measurements                                                                                                                                                                                                                                                                                                                                                               |
| IEC 60376               | Specification and acceptance of new sulphur hexafluoride                                                                                                                                                                                                                                                                                                                                                                    |
| IEC 60480               | Guide to checking of sulphur hexafluoride taken from electrical equipment                                                                                                                                                                                                                                                                                                                                                   |
| IEC 60060               | High Voltage test techniques                                                                                                                                                                                                                                                                                                                                                                                                |
| IEC 60071               | Insulation co-ordination                                                                                                                                                                                                                                                                                                                                                                                                    |
| IEC 60099-5             | Surge arresters<br>Part 5: Selection and application recommendations                                                                                                                                                                                                                                                                                                                                                        |
| IEC 60273               | Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V                                                                                                                                                                                                                                                                                                                  |
| IEC 61850               | Communication networks and systems for power utility automation                                                                                                                                                                                                                                                                                                                                                             |

## Regulation And Law

Any local regulation and /or law relevant to the enclosures shall be taken into consideration during the design.

## Service Conditions

The service conditions are specified in this specification, in case something is not or is not properly specified regarding the service conditions, the Reference Standards prescriptions shall be considered.

## Technical Features and Ratings

### (i) General

In these paragraphs the switchgear technical features and the ratings are described. The contractor shall propose its best solution, considering the characteristics reported in the present specification and annexes, the best technology available, maintenance, maintenance cost and cost of switchgear.

### (ii) Technical features

The switchgear shall comply with the following technical features:

- switchgear shall be complete in all respects necessary for their effective and trouble-free operation when connected to the system.
- All components shall be of approved and reliable design. The highest degree of uniformity

and interchangeability shall be attained. The design shall allow easy maintenance, fault diagnosis and repair of the components.

- switchgear should be designed to ensure that thermal interaction does not unduly affect the performance of any of the components.

### **Type of MV Switchgear (33 kV Gas Insulated)**

The switchgear shall be metal enclosed type, with circuit breaker fixed. The complete switchgear must be compact in dimension as space is very limited. Also, the Switchgear should be suitable for future extension or replacement of panels without affecting the gas enclosures. The Medium Voltage section must be maintenance free and immune to environmental influences. The installation must be resistant to accidental arcs. All switches are to be operated from the front. The circuit breakers must be remotely controllable.

Capacitive dividers in the bushing to the bushing to the cable terminal compartment are to allow safe testing for dead state at the panel front. The degree of protection of the switchgear must not be reduced here.

### **Internal arc classification (IAC)**

The enclosure of switchgear shall be IAC A-FLR classified according to IEC 62271-200 definitions. The compliance shall be proved with specific test reports. The switchgear shall be equipped with all necessary gas exhaust channels/ducts.

### **Loss of service continuity category**

Loss of service continuity, according to IEC 62271-200:

- LSC2A for fixed CB
- LSC2B for withdrawable CB Partition class shall be Metallic Compartmentation (PM), in all cases.

### **Current Ratings**

Every current-carrying part of the switchgear including current transformer, busbars, connections, contacts and joints shall be capable of carrying its specified rated current at rated frequency continuously, and in no part shall its temperature rise exceed that specified in relevant standards.

### **Corona**

Equipment shall be designed so as to minimize corona or other electrical discharge and radio interference. Tests for corona and radio interference shall be carried out by the manufacturer at his works and on Site.

#### **(iii) Switchgear Main Ratings**

Switchgear equipment ratings shall be as specified in the present Technical Specification, Annexes and data sheets.

The rated values refer to the equipment in service inside the switchgear considering the project design conditions based on the average daily temperature, the electrical data and the switchgear arrangement stated in the specific project documents.

| Rating                                                                                   | Feeder |             |             |
|------------------------------------------------------------------------------------------|--------|-------------|-------------|
|                                                                                          | Line   | Transformer | Bus Coupler |
| Rated Current [A]                                                                        | 2000   | 1250        | 2000        |
| Rated Voltage [kV]                                                                       | 33     |             |             |
| Rated insulation levels:<br>- Rated power frequency withstand voltage [kV, r.m.s. 1 min] | 70     |             |             |

|                                                              |               |
|--------------------------------------------------------------|---------------|
| - Rated lightning impulse withstand voltage [kV, peak value] | 170           |
| Rated short time current:                                    |               |
| - Rated short time withstand current [kA, r.m.s..3s]         | 31.5          |
| - Rated peak withstand current [kA, peak value]              | 80            |
| Rated earth fault current [kA]                               | 31.5          |
| Auxiliary Voltages                                           |               |
| - AC power supply [Vac]                                      | 415/240 ± 15% |
| - DC power supply [Vdc]                                      | 110± 15%      |

### Construction and Design Requirements

#### (iv) Common requirement

33 kV gas insulated switchgear shall be suitable for indoor location and capable of continuous operation under the climatic conditions existing on site. It shall be designed to comply with this Specification and relevant IEC where applicable.

In all cases, the ancillary plant necessary to complete installation of the equipment shall be included in the Contract.

For 33 kV GIS Switchgear, the individual panel should be connected by the Plug-in type or bolted type Busbar within gas. GIS Switchgear must be extendable at both ends of the bus bar for future extension provision and maintenance without affecting existing switchgear SF6 gas.

Metal enclosures shall be made from sheet steel, offering mechanical and thermal properties suitable for prevailing application. The equipment in the switchgear compartments must be accommodated with necessary clearances, easy access to the equipment for testing, maintenance, removal and normal operation and to provide safety measures against all possible hazards to the equipment in the particular compartment, such as internal arcing faults.

The enclosure of the switchgear must be so designed that internal arc faults are directed away from places where personnel or public may be present.

The switchgear of similar ratings/model/type shall have the same dimensions and components. The devices shall be interchangeable with those of other units.

All high voltage components/ parts must be fully gas insulated sealed hermetically and safe-to- touch. The Switchgear (primary section) panels shall be filled with insulating gas at site or in factory and fitted with gas monitoring device with contact. SF6 may be used as an insulating medium, not for quenching. For gas sealed volumes, the switchgear shall be designed for automatic pressure relief in case of pressure increase due to arcing, at the same time, ensuring that escaping gases are clear off the operating personnel in the front lateral, and rear of the switchgear (ALFR). The manufacturer must guarantee an adequate pressure reserve between the operating value of the pressure relief and the rupturing pressure of the vessels. The pressure relief facilities must limit the effects of a fault arc to one compartment.

Pressure monitoring takes place with contact-making manometer gauges, which function independently for each busbar section, CB section, three-position switch gas compartment or bus bar voltage transformer set respectively or temperature compensated gas sensors for each gas compartment facilitated with indicative meter and alarm system, which shall be equipped with self-supervision. Any pressure drops beyond the safe level as specified by the manufacturer shall be indicated in the form of sound and light alarm. In case of low gas pressure in gas section i.e CB section, bus bar section, cable section or otherwise, indicative signal (Red) will be shown separately. Also indicative signal (Green) will be shown always for healthy gas pressure in individual gas chamber.

The gas compartments must be well sealed both mutually and to their surroundings. The gas loss must not exceed 0.1% per year and compartment. The filling pressure must be selected so that after thirty years of operation the full test voltages can still be withstand, without any topping up.

Cast iron shall not be used for any part, which may be subjected to mechanical shock.

Adequate clearances and surface creepage distances shall be provided to ensure satisfactory performance under service conditions. Insulation creepage distances shall not be less than 25mm per kV rated voltage between phases.

The Contractor shall be responsible for ensuring that insulation coordination in accordance with recommendation of IEC 60071 is achieved. Dynamic and temporary over voltages shall be assumed to be in accordance with the normally accepted IEC levels.

In order to avoid possible condensation, all not-sealed compartments shall be provided with a space heater controlled by hygrostat, exception is allowed for busbar compartment with BREB approval. The heater shall be located at a suitable position and its capacity shall be as required to maintain the interval temperatures above the dew point.

Climatic sensor to be added that will compute the ambient condition cumulated over time to detect and inform any severe condition that can impact the performance, also will detect potential condensation. Sensors shall be of the same make as of the OEM and to be connected to SAS. The heating resistance shall be protected or suitable for direct touch without any harm, to avoid possible accidental contact during switchgear maintenance operation.

Moreover, the heating resistance shall be positioned in order to avoid excessive cable heating. The use of plastics must be minimized, in order to likewise minimize the risk of fire in the event of a fault. The use of any plastic/fibre materials is allowed only if the part is included in the manufacturer's original design and duly tested.

Any operation button/lever and selectors shall be mounted at suitable height not exceeding 200 cm.

#### (v) Main Component requirements

The following paragraphs showing single component requirements.

### **Busbars**

Contractors shall propose the optimum combination of busbar material (high conductivity copper) and cross section in order to meet the required rating.

#### **Main busbar**

- Main busbar must be Single busbar and single phase/ three phases encapsulated within gas. Busbar cross section and material shall remain uniform for all length of the busbar.
- The individual panels are to be connected by solid/gas insulated, plug-in bus bars or continuous bolted type or similar arrangement busbars as per the latest IEC standard. The bus bar is to be located in a metal-clad compartment.
- Main busbars shall be suitable for future extension at both ends of the switchgear without switchgear dismounting. Busbar extension shall preferably be possible though special bushing/insulators/connectors without gas handling. Extension and maintenance work shall be done without significant power interruption.
- Busbar supports may be insulators or moulded or laminated insulating supports; they shall be of non-hygroscopic and non-flammable material and manufactured to avoid superficial discharges due to dust deposit or formation of condensate. The bars shall

be clamped considering thermal expansion, vibrations and electrodynamic forces.

- For busbar voltage measurement, busbar VTs (see Table 8) shall be supplied. Secondary circuits shall be protected through MCB.
- VT shall be directly connected to busbar (withdrawable or plug in type) with required protection as per IEC Standard. PT connection shall not be done through cable.

### Three position switches

The three-position switch shall be spring operated. Spring charging shall be either manual or by means of motor fed by LV auxiliaries. The line switch shall be capable of both local operation (push buttons/levers) and remote operation (opening/closing contacts), while the earthing switch shall be capable of local operation only. The three-position disconnect or (ON-OFF-EARTH) is to reduce the number of functional elements within the encapsulation and together with the circuit breaker, provide make-proof earthing. In order to reduce the number of mechanical parts within the encapsulation, the operating shafts are to be located outside the encapsulation. The switches are to be operated without a seal via gas-tight welded-in bushings.

| Item                                        | Unit | 33 kV  |
|---------------------------------------------|------|--------|
| Electrical and Mechanical Endurance Classes | -    | E1, M1 |

| Item                       | Unit               | 33 kV |
|----------------------------|--------------------|-------|
| Making capacity            | kA <sub>peak</sub> | 80    |
| Electrical Endurance Class | -                  | E1    |

The three-position switch shall be equipped with:

- 4 NC contacts
- 4 NO contacts

The Earthing switch shall be equipped with:

- 4 NC contacts
- 4 NO contacts

### Circuit breaker

The circuit breaker shall be three pole spring operated. Spring charging shall be both manual and by means of motor. Operating mechanisms shall be trip free. Circuit breaker shall be equipped with Anti-pumping feature. The circuit breaker shall always have vacuum as quenching medium. If additional devices are required to limit overvoltage caused during switching to a safe level, these shall be supplied, and the details shall be submitted to BREB for evaluation. Opening and closing coils shall be fed by LVdc or LVac.

The arrangement of the Circuit-breaker in the panel must be such that in the event of any necessary inspections both the operating mechanism and the arc chambers can be removed and reinstalled from the front or back in a verifiably short time. The bus bars must remain uninterrupted and there must be no reduction in either the insulation level (additional measures such as protective barriers are not permitted) or personal safety. Confirmation must be provided with the quotation.

The Vacuum Circuit Breaker interrupter as a making/breaking unit, including operating mechanism, must be maintenance free.

The circuit breaker shall be equipped with:

- 1 closing coil.
- 2 opening coils suitable for Trip Circuit supervision (with CB in both closed and opened position).

Circuit breaker tripping operation shall be managed by:

- protection relay.
- transformer trip signal – for transformer feeder only

The circuit breaker operation shall be possible both from local (push buttons) and remote (opening/closing contacts)

The circuit breaker shall be equipped with operation counters.

The circuit breaker operating cycle shall be O – 0.3s – CO – 3 min - CO. The circuit breaker shall be equipped with:

- 9 NC contacts
- 9 NO contacts

Eventually additional contacts may be obtained with auxiliary relays.

|                                             |        |            |
|---------------------------------------------|--------|------------|
| Item                                        | Unit   | 33 kV      |
| Breaking capacity                           | kArms  | 31.5       |
| Making capacity                             | kApeak | 80         |
| Electrical and Mechanical Endurance Classes | -      | E2, C1, M2 |

## **-Operating Duty and Performance**

### **i) General**

The requirements of IEC-2271-100 in respect of type tests, service operation and the making and breaking of fault currents shall apply to all types of circuit breakers. Designs shall be suitable for interrupting 3-Phase ungrounded faults.

### **ii) Test Certificates**

Circuit breakers shall be covered by test certificates issued by an internationally recognized independent testing laboratory certifying the operation of the circuit-breaker at duties corresponding to the rated breaking capacities of the circuit-breakers. The test duty shall not be less onerous than the requirements of relevant IEC standard. Test certificates or equivalent shall be submitted with the Bid. Test certificates should conform with latest version of IEC standards for type test approval.

### **iii) Rate-of-Rise of Re-striking Voltage**

Attention is drawn to the requirements of the minimum inherent rates of rise of re-striking voltage of test plant arrangements. Where not specifically stated in the test certificates submitted with the Bid, the Bidder shall certify that the Transient Recovery Voltage (TRV) to which the circuit-breaker was subjected during the short circuit tests was the most severe condition that could be imposed by the available test plant for a first phase- to-clear factor of 1.5.

Any device incorporated in a circuit breaker to limit or control the rate of rise of restriking voltage across the circuit breaker contacts shall likewise be to the BREB's approval and full descriptions of any such device shall be given.

### **iv) Interrupting Duties**

In addition to the requirements of IEC 62271-100 for interrupting terminal faults, circuit-breakers shall be capable of coping with the interrupting duties produced by the switching of low inductive currents associated with reactors or transformer magnetizing currents, or by the switching of capacitor currents associated with overhead line-charging, cable-charging or capacitor banks as may be applicable.



Circuit breakers shall be capable of interrupting currents associated with short-line faults and the out-of-phase switching conditions that may occur in service.

The Bids should include a statement of the accumulative breaking capacity which the circuit-breakers are capable of before maintenance is required.

#### **v) Break Time**

Attention is drawn to fault clearance times (i.e., relaying time plus circuit breaker time).

#### **-Insulation Coordination**

The insulation strength across the open circuit breaker shall be at least 15 percent greater than the line to ground insulation strength for all impulse, switching surge and power frequency voltage conditions.

#### **Operating mechanism**

The spring mechanism shall operate the circuit breaker by means of separate two springs, for opening and closing. It shall not be possible for the circuit breaker to close unless the spring is fully charged. A visual indicating device, preferably mechanical, shall be provided to indicate the state of the spring with symbols. Indication lamps to indicate spring charged shall be provided where specified.

Each part of the operating mechanisms shall be of substantial construction, utilizing such materials as stainless steel, brass or gunmetal where necessary to prevent sticking due to rust or corrosion. The overall designs shall be such as to reduce mechanical shock to a minimum and shall prevent inadvertent operation due to fault current stresses, vibration or other causes.

Power closing mechanisms shall be recharged automatically for further operations as soon as the circuit - breaker has completed the closing operation and the design of the closing mechanisms shall be such that they cannot be operated inadvertently due to external shock forces resulting from short circuits, circuit - breaker operation or any other cause.

Circuit-breaker operating mechanisms capable of storing energy for at least two complete closing and tripping operations, local to the equipment and without recharging, are preferred. Mechanisms incapable of storing energy for at least two complete operations shall utilize the substation DC supply for recharging the mechanism.

A contact shall be provided to initiate a "Breaker Inoperative Alarm" if the operating spring is not recharged within a predetermined time.

Operation counters shall be fitted to all circuit-breaker mechanisms. Spring charging shall be by means of motor, fed by 110 Vdc. Recharging of the mechanism operating spring shall commence immediately and automatically upon completion of each circuit breaker closure. An emergency hand operated charging device shall be supplied.

A contact shall be provided to initiate a "Breaker Inoperative Alarm" if the operating spring is not recharged within a predetermined time since charging start.

#### **Operating Cubicles**

Circuit-breaker operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations and other ancillary equipment shall be accommodated in Aluzinc/anodized coated sheet aluminum vermin-proof and weatherproof cubicles. Where appropriate the cubicles may be free standing

Cubicles shall be of rigid construction, preferably folded but alternatively formed on a framework of standard rolled steel sections and shall include any supporting steelwork necessary for mounting on the circuit breaker or on concrete foundations. Bolts or carriage keys shall not be used to secure the panels or doors. All fastenings shall be integral with the panel or door and provision made for locking. Doors and panels shall be rigid and fitted with weatherproof sealing material suitable for the climatic conditions specified.

Cubicles shall be well ventilated through vermin-proof louvres comprising a brass gauge screen attached to a frame and secured to the inside of the cubicle. Divisions between compartments within the cubicle shall be perforated to assist air circulation. In addition, thermostat controlled anti- condensation heater of an approved type shall be provided and controlled by a single pole switch mounted within the cubicle.

Access doors or panels shall be glazed where necessary to enable instruments to be viewed without opening the cubicles. The arrangement of equipment within the cubicle shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance to associated apparatus.

Circuit breaker control position selector and circuit-breaker operating control switches as specified in the Specification shall be installed in the cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only.

Where practicable an approved schematic diagram of the part of the control system local to the circuit - breaker, identifying the various components within the cubicle and on the circuit-breaker and referring to the appropriate drawings and maintenance instructions, shall be affixed to the inside of the cubicle access door. The diagram shall be marked on durable non-fading material suitable for the specified site conditions.

## Earthing switch

Earthing switches shall be used as a standalone equipment.

Toggle springs shall be used for the earthing switch. The earthing switch has a snap action closing mechanism which functions independently of the rotation of the drive shaft. The switching speed and torque achieved in this process are independent of the actions of the operating mechanism. The earthing switch

shall be mechanically interlocked with upstream circuit breaker, in order to avoid:

- closing of the earthing switch while the circuit breaker is not in isolated or open position
- close the circuit breaker or move circuit breaker in service position while the earthing switch is in closed position.

| Item                       | Unit               | 33 kV |
|----------------------------|--------------------|-------|
| Making capacity            | kA <sub>peak</sub> | 80    |
| Electrical Endurance Class | -                  | E1    |

## Current transformers

Current transformers shall be designed in accordance with IEC Standards 61869 -1 and 61869-2 and the requirements of this Specification.

Magnetization and core loss curves and secondary resistance shall be provided for each type and rating of current transformer. Where the Contractor wishes to provide current transformer ratios differing from those specified, he shall first obtain approval in writing from the BREB for each specific instance.

Current transformers provided for protective gear purposes shall have over current and saturation factors not less than those corresponding to the design short circuit level of the system. The output of each current transformer shall be not less than prescribed VA with an accuracy limit factor of 20 and it shall be ensured that the capacity of the current transformers provided is adequate for operation of the associated protective devices and instruments. Where double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and ratio in use shall be shown on appropriate schematic and connection diagrams.

The insulation value of the CT shall be rated maximum system voltage 36 kV and nominal 33 kV, BIL-170 kV and power frequency withstand voltage for 1 min.70 kV.

| Item                         | Unit | Feeder           |                         |                  |
|------------------------------|------|------------------|-------------------------|------------------|
|                              |      | Line             | Transformer             | Bus Coupler      |
| Rated primary current        | A    | 1200-600         | 800-400                 | 1200-600         |
| Rated secondary current      | A    | 1                |                         |                  |
| Number of secondary windings | Nr.  | 4                | 4                       | 2                |
| Secondary core 1             |      |                  |                         |                  |
| Purpose                      | -    | Metering         |                         | Metering         |
| Burden                       | VA   | 15               |                         | 15               |
| Accuracy                     | -    | 0.2S FS5         |                         | 0.2S FS5         |
| Secondary core 2             |      |                  |                         |                  |
| Purpose                      | -    | Metering         |                         | Protection OC/EF |
| Burden                       | VA   | 15               |                         | 15               |
| Accuracy                     | -    | 0.2S FS5         |                         | 5P20             |
| Secondary core 3             |      |                  |                         |                  |
| Purpose                      | -    | Protection OC/EF | Protection OC/EF        |                  |
| Burden                       | VA   | 15               |                         |                  |
| Accuracy                     | -    | 5P20             |                         |                  |
| Secondary core 4             |      |                  |                         |                  |
| Purpose                      | -    | Protection OC/EF | Protection Differential |                  |
| Burden                       | VA   | 15               | Burden                  |                  |
| Accuracy                     | -    | 5P20             | Accuracy                |                  |

The following requirements are highlighted:

- The above-mentioned CT features are minimum preliminary; it is Contractor's responsibility to design the CT according to prescription stated in specification.
- Current transformers shall be capable of withstanding without damage at full load, peak and rated short time current.
- The Current transformer must be of the di-electrically non-stressed and must not be cable mounted.
- The Current Transformers are to be exchangeable toroidal-core or ring type current transformers which are to be used outside the SF6 encapsulation so that they are not exposed to dielectric stress.
- It is contractor responsibility to adapt CT rating to the requirement of the relay selected (burden, current rating).
- The thermal rating of the current transformer shall allow, at site conditions, a minimum of continuous overloading referred to nominal rating of the feeder:
  - a) 20% incoming/ outgoing line feeder
  - b) 50% for transformer feeder
- Where multiple ratios are to be implemented, this shall be achieved by changing the secondary connection only. Primary switching is not acceptable.
- The magnetizing curves for each CT, marking the points on the curve at which knee-point voltage is obtainable and also the corresponding excitation current, shall be submitted for approval by BREB.
- Contractor shall present CT rating selection calculations, both in steady state and transients, to BREB for approval before CT manufacturing. In CT rating calculation short time current specified shall be considered.

### Line Feeder and Busbar Voltage Transformer

Feeder Voltage transformer (FVT) and Busbar Voltage Transformer (BVT) shall be designed according to IEC 61869-1 and 61869-3 having the performance reported in Table 8.

The Voltage transformer on busbar must be designed for 80% Power frequency withstand voltage so that repeat tests can be carried out on the bus bar without removal of the transformer. However, the voltage transformer on bus bar must be capable of withstanding over 100% power frequency withstand voltage under normal operating conditions. The VT shall be protected on HV side with a fuse and on LV side by MCB. The VT shall be incorporated in switchgear panel. The fuse intervention shall be signalled locally by means of a signalling lamp on the front panel and remotely by means of a dry contact.

Separate sets of fuses or MCBs shall be provided at the VT for:

- Each protection schemes
- Instruments, recorder etc.
- Synchronizing

The circuits for each main protection scheme shall be segregated in separate multicore cables from the VT to the protection panels. An (VT failure) alarm shall be provided for each set of fuses and MCBs.

| Item                                    | Unit | 33 kV |
|-----------------------------------------|------|-------|
| Maximum system voltage                  | kV   | 36    |
| Power frequency withstand voltage for 1 | kV   | 70    |

|                              |     |                 |
|------------------------------|-----|-----------------|
| min.                         |     |                 |
| Basic Insulation Level (BIL) | kV  | 170             |
| Rated primary voltage        | kV  | 33/ $\sqrt{3}$  |
| Rated secondary voltage      | V   | 110/ $\sqrt{3}$ |
| Voltage factor               | -   | 1.9 Un / 8h     |
| Number of secondary windings | Nr. | 2               |
| Secondary winding 1          |     |                 |
| Purpose                      | -   | metering        |
| Burden                       | VA  | 20 (*)          |
| Accuracy                     | -   | 0.2             |
| Secondary winding 2          |     |                 |
| Purpose                      | -   |                 |
| Burden                       | VA  | 20 (*)          |
| Accuracy                     | -   | 3P              |

- (\*) 20 VA or more than actual connected burden whichever is higher. Total connected burden shall not be less than 25% of nominal burden.
- VT for the feeders shall be equipped with disconnection facility to be used in order to allow MV cable voltage testing without MV cable terminal dismounting. The busbar VT shall be equipped with disconnection facility (disconnecter, withdrawable).
- Contractor shall present VT rating selection calculations, to BREB for approval before VT manufacturing.

### Protection relay

Each feeder shall be equipped with multifunction protection in accordance with the Specification provided in protection scheme.

### Voltage signalling device

Each phase shall be equipped with a voltage signaling device capable at minimum of detecting phase voltage presence or phase voltage comparison. The voltage detection system shall be in accordance with IEC 61243-5

The signaling of voltage shall be made by high visible lamps positioned in the front and back of the panel.

### Surge Arresters

Surge arresters shall be of the type employing non-linear metal oxide resistors without spark gaps. The contractor shall demonstrate by calculations that the surge arresters will adequately protect the switchgear arrangement proposed. Surge Arrester shall be plug-in type.

Arresters shall be designed and tested in accordance with the requirements of EN 50181/ IEC standard. Any departure shall be the subject of agreement between the BREB and the Contractor. Routine tests shall be carried out in accordance with the requirements of the Specification.

### A.C. Motors

Motors shall be wound for nominal 400 volt, 3-phase, 50 Hz, 3 wire or 230-volt, single phase supply and be capable of operating under frequency variations of + 5 Hz. and/or voltage variations of + 10% starting is to be direct on line.

motors shall be either of the squirrel cage induction or commutator type. Where squirrel cage motors are to be used, cast rotor construction is preferred. Maximum starting current shall not exceed six times full load current.

### (vi) Cable entry compartment

In case of GIS switchgear, cable plugs (T-Plugs or plug-in type termination) with adequate size shall be used. Cable termination shall be totally insulated. Provision should be kept for plug-in connection of at least three cables per phase including provision for test plug and surge arrester connection. Cable entry compartment shall have enough space to host the above-mentioned cable and associated termination.

The cable termination work shall be carried out under the supervision of a skilled and certified engineer to ensure quality, reliability, and compliance with manufacturer specifications. The cable terminals of the 3 - Phases are to be located horizontally next to one another on one level and are to be easily accessible from the front or rear.

Cable gland plates, unless otherwise specified, shall have glands pointing vertically downwards. Contractor is responsible to obtain from BREB the required information of the MV cable and accessories to be connected for the specific project. Cable compartment shall be supplied with a copper earthing bar suitable for cable screen connection and earthing. The minimum cross section of the earthing bars shall be 300 mm<sup>2</sup>.

(vii) **Earthing facilities**

The Switchgear shall be equipped with copper earth busbars to which all metal parts shall be connected. Two threaded terminals of suitable size complete with nuts and robust flat washers at suitable locations of the Switchgear shall be provided for connecting to the external earthing grid.

All metal work including Switchgear tanks, cable sheaths/screens, door and any internal structural Steel work shall be securely bonded together so that a firm metallic connection exists between each of them and the substation external earthing.

Earthing circuits shall be sized and anchored to withstand thermal and dynamic effects of short-circuits in accordance with the short-circuit capacity requirements without permanent deformation, nor breakage.

(viii) **Padlocks**

Provisions for padlocks and padlocks shall be provided on the Switchgear for locking the marshalling compartments or other live parts of the Switchgear to be opened during maintenance. Padlocks shall be provided as listed below (three ordinary keys for each lock shall be supplied)

- Locking the Disconnecter/Earthing Switch in the isolated and earthed position
- Locking the C.B. control switch
- Locking the local/remote switch.

Padlock arrangement shall be submitted to BREB for approval.

(ix) **Test Facilities**

For GIS switchgear, each feeder shall be equipped with a cable test facility used for testing cable insulation and to locate faults in the circuit without the need to remove the main cables. The test facility access shall be interlocked with the feeder earthing switch.

(x) **Structure and enclosure**

The Switchgear structure and enclosure shall comply with the following requirements:

- The switchgears shall be self-supporting, and manufactured materials able to withstand the mechanical, electrical, thermal stresses and suitable for the corrosion phenomena resulting from the project design conditions.
- The Switchgear shall be indoor type unit.

- Enclosure must be suitably ventilated according to the ambient conditions.
- Sheet metal for the Switchgear enclosure must be suitably treated and painted, to achieve worthiness and corrosion protection as per IEC Standard.
- Each Switchgear's panel shall be provided with four lifting lugs for easy lifting and positioning of the whole unit at site by the use of crane. The Switchgear shall be strong to withstand transportation and handling stresses.
- The structure shall be suitable for fixing to the floor of the control room building by means of a base frame, with anchor bolts and nuts, to be supplied by the switchgear manufacturer.
- The section closing covers and plates shall be fixed by screws and rivets.
- The Switchgear shall have IP4X degree of protection.

(xi) **33kV Gas Insulated Busbar**

The busbar system must be compact and fully insulated "touch safe" gas insulated system. The conductor should be solid copper in ETP-H quality (Electrolytic –Tough Pitch High Purity) aka HDHC quality (Hard Drawn, High Conductivity).

**Requirements for the gas insulated Busbars:**

- Single phase/three-phase encapsulated phase bus, fully earthed for human safety
- Safe service conditions, even in high ambient humidity
- Partial discharges free operation
- Suitable for complete Indoor operation
- Short-circuit safe system (no damages in case of short circuit for any reason)
- Operating ambient temperature of +45°C
- The Ingress Protection class shall be not less than IP65

**Connection at the Switchgear**

If the insulated bus bar to be connected to the SF6 insulated switchgear, the connection shall be gas tight, and pressure tested. The connection point shall undergo type testing for short circuit at the same SC level of the switchgear to which it is connected and shall also undergo temperature rise type test.

**Electrical Tests of the Busbars**

Each individual Busbar should be Factory tested according to IEC 60137, 2008, clause 9.1, 9.3 and 9.4/ latest revision. As a minimum the following tests shall be carried out:

- Measurement of the dielectric dissipation factor and the capacitance at ambient temperature
- Dry power frequency voltage withstand test.
- Lightning impulse voltage withstand.
- Measurement of the partial discharge level.
- Contact Resistance Measurement.
- Temperature rise test including joints.
- Verification of thermal short time withstand.

**Fittings and Tools**

All Switchgears shall be provided with:

- All special necessary accessories and tools required for installation or dismantling purpose either of Switchgear or component, if applicable.
- All accessories for mechanical and electrical assembly on site such as: bolts, washers, cables and connection bars between sections, etc.

- A series of keys and special tools (in general one set one for each electrical substation of the plant and one for the workshop).
- The type of keys and tools shall be reduced to a minimum consistently with the safety requirements.
- The quantity and the type of these keys and tools shall be such as to allow complete installation and maintenance of the switchgear, of each single functional unit component.
- Lugs for Switchgear lifting.
- Truck trolley or rail system for CB extraction (if required).
- All tools, nut-bolts, fittings etc. shall be of manufacturer's standard.

### **Label and nameplates**

Identification of circuits and component shall be in accordance with BREB specification. In addition, each switchgear, each functional unit and each equipment shall be provided with the necessary nameplates as per IEC 62271-200 requirements, fixed with screws or rivets and bearing engraved wording for nameplates and tag numbering.

Each switchgear nameplate (subject to approval by BREB) shall be fitted to the front of the switchgear and bear the at least following information:

- Manufacturer name.
- Manufacturer code number.
- Product type/Model number/Manufacturer serial number.
- Year of manufacturing.
- Rated frequency, Hz.
- Rated voltage, kV.
- Line/Transformer feeder rating current, A.
- Rated short circuit withstand current, kA/3s.
- Auxiliary rated voltages, kV.
- SF6 pressure (in Bar absolute) @ 30°C
- Project name
- Contract No.
- Others as required.

Moreover, each switchgear shall also be supplied with danger signs, fixed with four stainless bolts at each compartment access door (subject to approval by BREB). Danger Signs in English and its Bangla translation shall bear the following information:

- DANGER 33000 VOLTS.
- PROPERTY OF BREB.
- BREB Logo.

Material shall be as per manufacturer standards durable for the entire lifetime of the switchgear.

### **Tests**

All required tests must be in accordance with BREB requirement.

### **Type Tests**

The following tests shall be carried out as a minimum requirement according to IEC Standards 62271-200:

- Tests to verify the insulation level of the equipment.
- Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of circuits.
- Tests to prove the capability of the main and earthing circuits to be subjected to



the rated peak and the rated short time withstand currents.

- Tests to prove the making and breaking capacity of the included switching devices.
- Tests to prove the satisfactory operation of the included switching devices and removable parts.
- Tests to verify the IP protection code.
- Additional tests to verify auxiliary and control circuits.
- Tests to verify the protection of the equipment against mechanical impact.
- Tests to verify the protection of persons against dangerous electrical effects.
- Tests to verify the strength of gas-filled compartments.
- Tightness tests of gas- or liquid-filled compartments.
- Tests to assess the effects of arcing due to an internal arc fault (for switchgear and control gear classification IAC).
- X-radiation test procedures for vacuum interrupters.
- Tests to verify the protection of the equipment against external effects due to weather.
- Dielectric tests on cable testing circuits.

All tests should be carried out by Internationally recognized test laboratory like KEMA/CPRI/ equivalent institution.

### **Sample Tests/ FAT**

The following minimum tests shall be carried out in the presence of BREB/PISC on the selected samples of SWITCHGEAR. However, BREB/ PISC have a right to add/delete any test.

- Visual inspection.
- Verification of dimensions of various components including thickness of galvanizing.
- Functional tests of all major components according to the Specifications and relevant IEC standards.
- Functional checks of Protections relays, CT's, control / interlock circuits.
- The visual inspection of the various components of SWITCHGEAR shall be performed in accordance with the list of defects set forth below:

#### **Material**

- Parts not made of material as specified.
- Any component missing or damaged.

#### **Finish**

- Dirt, grit or foreign matter embedded in finish.
- Painting work not in order.
- Pits, Cavities on the surface of components and busbars. The contact surface of switches and breakers not being smooth and uniform in thickness.
- Steel parts rusted.

## Construction

- Construction of any major components not as per specification or good engineering practice.
- Nuts and bolts not tight.
- Nuts not freely moving or loose on threads.
- Doors of the external housing do not fit properly.
- Welding not proper.
- Locking arrangement not proper.
- Earthing straps between doors and housing not adequate size.
- Marking/name plates.
- Caution notices missing, not legible, incomplete or not permanent.

## Routine tests

The SWITCHGEAR and their components shall be subjected to routine tests as per IEC 62271 -200 recommendations. Routine test certificates shall be submitted for BREB's review and approval before shipment of the SWITCHGEAR.

The visual inspection of the SWITCHGEAR, in order to ensure that all components are mechanically assembled and fixed properly and that there are no imperfections shall be performed. The following routine Tests, but not limited to, shall be performed:

- Dielectric test on the main circuit.
- Tests on auxiliary and control circuits.
- Measurement of the resistance of the main circuit.
- Tightness test.
- Design and visual checks.
- Partial discharge measurement (for GIS only).
- Mechanical operation tests.
- Pressure tests of gas-filled compartments.
- Tests of auxiliary electrical, pneumatic and hydraulic devices.
- Tests to verify locking devices and interlocks function.
- Tests to verify electrical continuity of metallic frame and earthing system.
- Verification of provision of two earthing terminals.
- Verification of clearances and other fittings.
- Verification of correct wiring.
- Inspection and tests on all facilities (auxiliary contacts, SF6 pressure indicator, Local /Remote switches, ON/OFF Switches, motor, Terminal box, all wirings etc.) required for SCADA/ SAS as specified.

## Site Tests

The Contractor shall carry out electrical and function tests when installation of the SWITCHGEAR has been completed. The tests shall comprise but not limited to the following:

- Voltage test of the main circuit (as per 62271-200).
- Tightness tests (as per 62271-200).
- Measurement of fluid condition after filling on site (as per 62271-200), where applicable.
- Visual and wiring checks for the equipment installation & wiring.

- Insulation resistance test.
- Secondary/Primary injection test.
- Relay test.
- CT & VT Tests.
- Checking of proper annunciation system operation.
- Calibration and adjustment of instrumentation.
- Interlocking checks.
- Functional checks on Control, Protection and Monitoring Equipment.
- Measurement of closing and opening speeds and times (circuit breakers).

## Quality and Certification

### (xii) Documentation supplied during the tender

The technical documentations to be produced by the Contractor for the financial offer shall contain the following items:

- Overall drawings with front views, dimensions, mass, foundation loading.
- Static and dynamic loads.
- Complete switchgear data sheets/Technical Requirement and Guarantee Schedule.
- Single line diagram.
- Equipment list main data and MFR reference code.
- Reference list for the proposed switchgear for the last 5 years.
- Inspection Testing Plan (ITP).
- Site Inspection Testing Plan (S-ITP).
- Type tests reports (issued by the manufacturer and an internationally recognized testing institutions).
- List of deviation from tender specification.

### (xiii) Document to be supplied after the order

The technical documentation to be produced by the Contractor after the order shall contain the following items:

- Overall drawings with front views, dimensions, mass, foundation loading.
- Static and dynamic loads.
- Complete switchgear data sheets/Technical Requirement and Guarantee Schedule.
- Single line diagram.
- Schematic Diagrams.
- Logic Diagrams (if any).
- Equipment lists main data and MFR reference code.
- Utilities consumption and heat losses.
- Interconnection terminal block diagram.
- Base frame and cable entry dimensions.
- Name plate.
- Inspection Testing Plan (ITP).
- Site Inspection Testing Plan (S-ITP).
- Routine tests reports (issued by the manufacturer).
- Type tests reports (issued by the manufacturer and a recognized authority).

- Data for health, environment and safety (if applicable).
- Quality plan.
- Production plan.
- Installation instructions.
- Operating instructions.
- Maintenance instructions.
- Complete test report book.
- Other documents indicated in the Purchase Order.
- Data sheet of all accessories installed.
- Painting procedure approved by BREB.
- SF6 zoning

### **Documentation for homologation, certification, and approval (TCA)**

Each MV switchgears type shall be subject to Technical Conformity Assessment (TCA) procedure managed by BREB/ PISC personnel supported by accredited Third Party.

The Contractor shall submit, for each Switchgear type, an Identification File (as per IEC 62271 -1). Such Identification file will follow the product during all the Type Tests, proving and assuring the identity of the MV switchgear along the whole process of test/certification.

Technical documentation included in the Identification file can be divided in two families.

**TYPE A DOCUMENTS:** Not reserved documentation is the documentation issued by the Manufacturer that allows to verify, directly or indirectly, the compliance of the MV switchgears with the prescription of this specification. The Manufacturer authorizes the diffusion and the reproduction of this documentation within the BREB/ PISC.

It shall contain at least:

- List of all the documents, including the list of the reserved documentation (Type B).
- List of the Contractors of the main components and parts.
- Manual of the transport, installation, operation and maintenance.
  - Single line diagrams.
  - Overall drawings and relevant details of both the completely assembled MV switchgears (as in operation) and of the MV switchgears transportation.
  - Drawing and schematics of the auxiliary circuits.
  - CTs and VTs details.
  - Interlock diagrams.
  - Test reports of the MV switchgears.
  - Test reports and certifications of the subcomponents and materials used.

**TYPE B DOCUMENTS:** The documentation considered reserved, of which the Contractor does not authorize the diffusion, used to completely identify the design and the manufacturing of the switchgear and its components.”. Such documentation will be overviewed by the BREB/ PISC representatives or by the certification body during the homologation or certification and will be archived by the Contractor.

Type test extension of validity: if during the certification process a type test extension of validity shall be required, the guidelines and criteria of IEC TR 62271-307 shall be followed.

The TCA certification shall have a prolonged validity as far as the switchgear shall remain available in the market.

Once the TCA certification is obtained, the Contractor is responsible to inform BREB/ PISC for any modification of the switchgear in comparison with the Identification File approved. Example of modification is the change/update/modification of any product/equipment/component forming the switchgear.

In such event the Contractor shall inform BREB sending at least:

- Updated/revised Identification File.
- Detailed report describing each modification and associated impacts on the certified performances.
- Evaluation of the need for type-test repetitions, based on guidelines and criteria of IEC TR 62271-307.

BREB supported by accredited Third Party shall verify the Contractor documentation, eventually asking for additional data and/or test to be performed.

### **Delivery, Handling and Logistic Issue**

#### **(xiv) Packaging and transportation**

The Contractor shall be responsible for all delivery procedures and provisions for storing the MV switchgears in factory after the tests and until the transport operations. The contractor shall pack the equipment with a suitable cases and protective measures granting the safe delivery of the good at the final place of installation.**Exceptions**

Possible exceptions to the present prescriptions, concerning the adoption of technical and/or manufacturing aspects different from the ones prescribed in the present Technical Requirement and Guarantee Schedule, can be evaluated by BREB.

In such a case, BREB will take into account the opportunity to require additional tests with regard to the technical/manufacturing proposed solutions. Such exceptions can be approved by BREB.

### **Technical Requirement of 33 kV Control, Relay & Metering Panels (CRP)**

#### **33 kV Control, Signaling, Metering and Relay panel for Transformer Feeder**

The 33kV switchgear panel shall have all indicating facilities of indicating three phase currents, voltages, kW, kVAR, kVA and frequency. In addition to the multifunctioning meter, there shall be one revenue meter of class 0.2S for 3-phase 4 wire four-quadrant measurement of real and reactive energy with facilities for testing of their accuracy through optical impulse.

There shall be protective relay viz. Transformer differential relays, REF, three phase over current and earth fault relay (IDMT and Instantaneous operation), mimic diagram with circuit breaker control & indicating switches, indicating lamps to trip circuit indicating readiness for closing and healthy trip circuit indicating readiness for tripping. Signaling relays (compact type) of adequate nos. to yield audio-visual signals on faults and have reset. The inside of the panel will have all auxiliary relays to sense the operation position of gas relays (Buchholz for Main and OLTC Tank), oil surge for OLTC, over temperature, PRD, low oil level, failure of PT supply and auxiliary voltages (DC & AC), etc. and to transmit for tripping and fault signaling to audio visual devices. The panel annunciator shall have facility to generate audio signal as well as visual signal. All inside equipment shall be neatly arranged inside the panel. Thermostat controlled heater; illumination bulb shall be provided. The terminal block for connecting the incoming multi core cables shall be placed at the bottom part and necessary glands/opening shall be provided for the entry of the outside cables. Sufficient working space shall be inside the panel between instruments and wiring for easy approach.

The protection scheme shall have master Trip Supervisory relays having Main protection & Back-up protection and they shall be DC polarity independent. The type of all the protection relays shall be Numeric and All protective relays shall be connected through test terminal blocks and the required test plugs shall be provided.

All numerical relays shall have facilities of downloading & uploading relay settings through communication port. These relays shall also have event record facilities.

All AC, DC auxiliary power circuit and PT secondary circuits entering the control panel shall be provided with MCCBs. DC MCBs shall be used for DC voltages. Mimic diagram with control and position indicating switches shall be on the control panel. Light signal of the local/remote position of control switch shall be there. DC horn and AC bell will be there for audio signals on fault. Push buttons for acknowledgement of horn/bell, resetting of lamp & bulb testing will be provided. Besides the provisions of control, signal, protection and measuring described, any other provisions to suit with the requirement of associated equipment of the concerned feeder shall be provided. All meters and relays shall be flush mounting. There shall be panel grounding terminal.

The Bidder shall quote the particulars of various protective relays, meters, aux relays, signalling relays, discrepancy control and position indicating switches etc. of the control panel, mentioning the names of the manufacturers.

#### **33 kV Control, Signalling, Metering and Relay Panel for incoming/outgoing feeder:**

Same as specification of 33 kV Control, Signalling, Metering and Relay panel for Transformer Feeder except that:

- i) Directional over current & earth fault relays will be there in this panel.
- ii) Synchro check relays shall be there if line PT is available.
- iii) Other features required only for a transformer feeder will not be there.

#### **33 kV Control, Signalling, Metering & Protection Panel for 33 kV Bus Coupler Panel.**

Same as specification of 33 kV Control, Signalling, Metering and Relay panel for Transformer Feeder except that:

- i) The bus coupler panel shall have synchro check relay. 02 nos. of voltmeters shall be Mounted with six (06) position selector switch to monitor the voltages of both sides of bus coupler panel.
- ii) There will be no energy meter in bus coupler panel.
- iii) Other features required for a transformer feeder will not be there.

## **Control, measuring and signalling**

The controls of line disconnectors and circuit breakers and of all other power equipment shall always be possible both by remote and locally from the front of the panel. Earthing switch control shall be only local, remote control for earthing switches is not required. The switchgear shall be equipped with mimic diagram of suitable size showing the feeder, preferred position is on the switchgear front panel. The mimic material shall be suitable for the environment and shall be able to withstand possible heating due to internal fault without fading and/or melting.

Status, alarm and trip signals, of each functional unit shall be available on the front panel or through lamps/indicators and to marshalling box with NO/NC contacts. Status, alarm and trip signals, of each functional unit shall also be wired at the terminal strip for external connections. Local operation and interlocks shall be performed with hardwire system (actuators, selectors, push buttons, individual lamps mounted on the front of switchgear) and not by microprocessor relays.

The Switchgear shall have all the monitoring and control facilities necessary for integration into SCADA/SAS. The required features are detailed below (These are minimum features; contractor must add others as required by the project).

- ON/OFF indication of all the equipment (CBs, Switches, Earthing etc.).
- Remote indication (low pressure alarm) of gas compartments, where applicable.
- Local / Remote selector Switch. All functional units shall be suitable for local control and for remote control, the choice of the operation shall be possible through a selector switch (local/remote position) provided with padlock. With the Switchgear in local mode any remote command shall be inhibited. With the Switchgear in remote mode any local command shall be inhibited.
- Wiring between interface cubicle and SCADA/SAS.
- Opening/closing commands from SCADA/SAS to switchgear.

## **Local, Remote and Supervisory Control**

Circuit breakers and motorized disconnectors shall be electrically controlled locally, remotely and by supervisory control.

Position indication of these devices shall be provided via auxiliary switches on their operating mechanisms and the Contractor shall include the supply and fitting of the necessary auxiliary switches. For supervisory control, the interface between the automation devices and the control equipment being provided under this Contract shall be as specified in Guaranteed Technical Particulars (GTP).

## **Interface Cubicle**

A remote-control interface cubicle (IFC) for data dispatching and switching from the SCADA/SAS shall be provided, to accommodate the required interface wiring for all switches, earthing switches, circuit breakers, alarms, and protection trips. Each Switchgear panel shall be equipped with Local/Remote selector positioned in the interface cubicle. Wiring between the Switchgear and the Interface Cubicle shall be provided as specified in the signal list for substation.

The following facilities and signals shall be incorporated in switchgear noting that command relays and transducers shall be provided in interface cubicle (These are minimum features; contractor must add others as required by the project):

- Earth fault protection TRIP
- O/C protection TRIP
- MCB ALARM

- SF6 ALARM (where applicable)
- Disconnect/Earth Switch ON/OFF/Earthed
- CB Status OPEN/CLOSE
- CB CONTROL OPEN/CLOSE
- Earth fault indication
- AUXILIARY VOLTAGE ALARM (common)
- PROTECTION RELAY FAULT for Transformer Feeder Only.
- BREAKER INOPERATIVE BIOP ALARM [Trip Circuit Supervision and Breaker Failure]
- Signal for Spring Charge/ Motor Operation

The wiring between the Switchgear and the Interface Cubicle shall be provided with proper mechanical protection.

#### (xv) **Auxiliary Switches and Contacts**

Circuit-breakers, Disconnectors and earthing devices and circuit selector disconnectors shall be provided with suitably rated auxiliary switches and contactors, where permitted, to relay circuit information for the purpose of control, protection, indication and metering at the substation site as required by the relevant section of the Specification. In addition, they shall be provided with auxiliary contacts for position indication to the central system control room via the remote supervisory system. Disconnector auxiliary switches are not to be used for current transformer switching circuits.

Auxiliary contacts shall be provided only where the circuit requirement cannot be met by the auxiliary switch arrangements and multiple contacts and relays will not be accepted in lieu of the auxiliary switches except as specifically approved by BREB. Auxiliary switches and contacts shall comply with the requirements of this Specification and in particular shall be capable of operation within the same voltage limits as specified for the associated circuit-breaker close and trip coils.

The connections of all auxiliary switches, including spares, and contacts as well as the associated coil connections and interconnections between auxiliary switches, shall be wired to a terminal board located in the operating.

Auxiliary switches and contacts shall be mounted in an approved accessible position clear of the main operating mechanism but with a minimum of additional mechanical linkages and housed in a substantial weatherproof enclosure. Where adjustable linkages are provided to facilitate the timing of the auxiliary switches with respect to the main equipment, approved locking devices shall be fitted. Auxiliary switch contacts shall be positively operated, make with a wiping action and, where necessary, discharge resistors shall be provided to prevent arcing when breaking inductive circuits.

Except for the contacts employed for control and interlocking, the requirements for auxiliary switches in respect of timing shall be as follows:

#### **For Circuit Breakers**

Normally open contacts, with the exception of two sets of this type, shall close in about 10 milliseconds after the making of the main circuit-breaker contacts and shall open in about 10 milliseconds before the separation of the main circuit-breaker contacts whilst the two remaining sets shall close in about 5 milliseconds before the making of the main circuit breaker contacts and open simultaneously with the main circuit contacts.

Normally closed contacts shall close 10 milliseconds after the opening of the main circuit-breaker contacts and open at least 10 milliseconds before the making of the main circuit-breaker contacts.

#### **For Busbar Disconnectors**



The operating sequence of any disconnecter auxiliary switches used in D.C. circuits for high impedance bus bar zone protection shall be such that the auxiliary switches operate:

- a) Before reaching the pre-arcing distance on closing the disconnecter.
- b) After the pre-arcing distance has been exceeded on the opening of the disconnecter.
- c) For Earthing Switches

As for Busbar disconnecter auxiliary switches, Auxiliary switches shall be adjustable from normally-open to normally-closed or vice-versa.

#### (xvi) **Interlocking Facilities**

Switchgears shall incorporate a system of mechanical interlocks between switching equipment to cover all safety requirements.

The items of plant supplied under this Contract shall be complete with all interlocking facilities needed for the final arrangement, avoiding the need for future modifications. Where mechanical key interlocks are employed, they shall be effective at the point where hand power is applied so that stresses cannot be transferred to parts remote from that point. Tripping of the circuit breaker shall not occur if any attempt is made to remove a trapped key from the mechanism. Emergency tripping devices shall be kept separate and distinct from any key interlocking system and shall be clearly labelled, suitably protected from inadvertent operation but readily accessible.

Wired interlocks (i.e. dependent on relays or in general on the protection & control system) shall be provided. This requires auxiliary contacts at the equipment level. All electrical interlocks shall so function as to interrupt the operating supply, and an approved system of interlocks shall be provided which shall cover the emergency hand operation of apparatus which is normally power operated. Failure of supply (or its restoration after an outage) or of connections to any electrical interlock shall not produce or permit faulty operation. Electrical bolt interlocks shall be energized only when the operating mechanism is being operated. Visible indication shall be provided to show whether the operating mechanism is locked or free. Approved means, normally padlocked, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies. Interlocking between the Circuit breaker and three position switches should meet the following conditions:

- to prevent the disconnecter from switching under load, they may only be actuated with the circuit-breaker is open.
- the three-position switch must be prevented from switching through from the closed state in to the "ready-to-earth" position.
- the three-position switch can only be brought into the earthing position if the circuit breaker is open.
- closing of the circuit-breaker must be blocked for as long as the three-position switch has not reached a definite switching position.
- for earthing of the feeder, reliable "interrogation interlocking" must be provided. Only the three-position switch is switched into the "ready-to-earth" position, feeder can be earthed and short-circuited by closing the circuit-breaker.
- opening of earthing switch not allowed if the cable compartment door is open.

#### **Protection against direct contacts with energized parts or parts in motion**

The live parts of the power, control and auxiliary circuits shall be located and protected in such a way that trained maintenance personnel may carry out the following operations with the energized switchgear without danger of direct accidental contacts (involuntary):

- visual inspection.
- control and reset of relays and auxiliary switching devices, inspection of signaling devices and instruments.

- replacement of fuses, lamps, electronic cards etc.
- connections of auxiliary cables.

The equipment for which maintenance operations are provided (relay wiring, fuse replacement, etc.) shall be positioned so that these operations can be performed easily from the front of the switchgear without having to remove the with drawable parts (where applicable).

### **Gas pressure Indicator**

In case of GIS switchgear, each individual gas compartment shall be provided with a dedicated gas pressure temperature compensated indicator. This indicator shall be arranged to give individual compartment indication in the local control units/front panel and remote alarms in case of low pressure. When the pressure is normal the indicator shall show that the switchgear unit is ready for use. The gas pressure indicator equipment must have the provision to make closing interlock.

### **Auxiliary Power supply**

Switchgear shall be provided with separate terminals in LV compartment to connect the LV auxiliary power supply for:

- Space heaters.
- Other a.c. users.
- Auxiliary circuits (e.g. signalling lamps).
- Opening, closing.
- Spring loading system.
- Protection/communication

LV ac power supply shall be 400/230 Vac and 110 Vdc (From DC Panel). Each external supply shall consist of an isolating switch with pad lock facility. The incoming switches shall be provided with auxiliary contacts for local and remote alarm.

### **Miniature circuit breakers and fuses**

Miniature circuit breakers shall be used for protection of auxiliary circuits. Miniature circuit breakers shall be in compliance with IEC 60947; they shall open all phases and neutral and shall be provided with two contacts (1 NO + 1 NC) auxiliary contacts wired for local and remote alarm.

### **Actuators, push buttons and contactor relays**

Actuators, push buttons, and contactor relays shall meet IEC 60947 requirements. The actuators shall be in principle selector switches with and without springs positioned and coloured according to their function (black for general purposes; red for emergency stop; blue for lamp test).

### **Auxiliary Relays**

Auxiliary relays shall meet IEC 60255 requirements, shall be plug-in type with the base suitable to avoid wrong insertions and suitable for permanent energization without economy resistor. In general, they shall have 2NO + 2NC contacts.

### **Signalling lamps**

Lamps shall meet IEC 60947 requirements. The lamps shall be light emitted diode (LED) type. In accordance with IEC 60073 indicators and actuators will have the following colors only:

RED, YELLOW, GREEN, BLUE, BLACK, GREY, WHITE

| Color                  | Meaning                          |                      |                    |
|------------------------|----------------------------------|----------------------|--------------------|
|                        | Safety of persons or environment | Condition of process | State of equipment |
| RED                    | Danger                           | Emergency            | Faulty             |
| YELLOW                 | Warning/caution                  | Abnormal             | Abnormal           |
| GREEN                  | Safe                             | Normal               | Normal             |
| BLUE                   | Mandatory significance           |                      |                    |
| WHITE<br>GREY<br>BLACK | No specific meaning assigned     |                      |                    |

Indicators the colors shall be:

- GREEN: Sequence or functional unit ready for operation.
- WHITE: Circuit closed and user in service.
- RED: Protection trip.
- YELLOW: Earth switch closed.

Moreover, reach panel shall be supplied with indicating lamp for:

- Protection relay failure
- TCS alarm (circuit breaker)
- Spring charged (circuit breaker)
- LV AC/DC failure (MCB open)

Each panel shall also be equipped with lamp test facility, to test lamps functionality. Lamps shall be easily removable and replaceable from the front of the panel and shall not be requiring the use of extractors. The variety of indicating lamps provided shall be rationalized to reduce maintenance and spares requirements.

### Low voltage wiring

In selecting cable and wire sizes, due regard shall be paid to the appropriate de-rating factors in relation to the climatic conditions at site. All cables and wires shall continuously carry their rated currents under the specified worst temperature conditions, which prevail in summer, and shall also withstand maximum fault currents without damage or deterioration.

All secondary copper wiring within Switchgear, etc. shall be in accordance with the relevant IEC standards, it shall be chosen to withstand the test voltage of 2kV AC/ 1 min (type tested) and shall consist of copper wires. Generally, for wiring, the cable tails shall be so bound that each wire may be traced back to its associated cable without difficulty.

Extra 10% spare cores and their respective terminals of each cable type shall be provided.

- All spare contact from the relays, breaker, disconnect/earth switch, etc. shall be terminated up to the terminals.
- At least, 10% of spare terminals shall be provided in addition with one in each special type of terminal such as CTs, power, etc.
- Terminal references for example XA-XD should be for CT circuits, XK for Control circuits, XL for indication circuits, XJ for DC circuits for AC circuits and XX for LDC circuits should be followed.
- Terminal Block to be installed which should be clearly visible and easily accessible.
- Test switches should be provided with test/service selector switch for all protection relays/BCU/BCPU with automatic CT shorting (make-before-break) should open when test plug is inserted.

- CT secondary wiring & terminals shall be color coded and the CT secondary terminals shall be disconnected type with shorting links with test socket shall be disconnected type with test socket and the same should be incorporated in the drawing. All control circuit terminals shall be disconnected type.
- All the internal wiring should be terminated in one side of the TB and the External wiring should not be mixed with internal wiring.
- All the trip circuits should be supervised by in built trip circuit supervision relay.
- Relay in test, General alarm, and Protection relay operated indication lamps shall be provided. All power circuits, control and protection wiring, and low-level signal wiring shall be physically separated.
- Each group of wiring of each terminal block shall be bundled separately and avoid crossing between wires of different terminal blocks.
- All control wires to be tested (Insulation, Voltage, Current etc.).

All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to terminal blocks in such a manner that, wherever practicable, wiring can be easily checked against drawings. Internal terminations of standard conductors shall be made with solderless crimping type tinned, suitable lugs which shall firmly grip the conductor, or by an equally suitable method. Insulating sleeves shall be provided over the exposed parts of lugs.

Core identification ferrules marked to correspond with board wiring diagram shall be fitted at both ends of each wire. Cross ferrule numbering (source end and remote end) should be provided for all the wiring. Ferruling shall be as per manufacturer's practice based on global standard. Separate ferrule numbering and identification shall be attached to the wires connecting the protective relays, even if the numbering and identification are printed on the wires themselves. As far as possible, all circuits shall be routed along the shortest path to their destination but shall be run only in horizontal and vertical planes. Diagonal runs are not acceptable.

However, the wire runs shall not block access for ready test or removal of any device without disturbing other devices. If wiring is provided to equipment that is installed on doors, bundled conductors shall be used on the door with extra/flexible wire, which shall be arranged such that twisting rather than a bending motion, is imparted to the moving bundled conductors. Each bundle shall be anchored so that the moving bundle length is the maximum available without loops.

Conductors between terminal blocks and apparatus shall be properly bunched and this bunch would run through a plastic conduit to ensure mechanical protection. All power circuits, control and protection wiring, and low-level signal wiring shall be physically separated. The working voltage of each power circuit shall be marked on the associated boards. Conductor ends, not connected to compression-type terminal blocks, shall be provided with approved claw-washers, which neatly retain all strands. "Push-on" or "quick" type connectors shall not be used for current transformers and trip circuits. These connectors may be used for alarm and control system and within an equipment assembly only. Sample of such connectors shall be submitted for BREB's approval.

Wiring shall be arranged to give easy access to the terminal or relays and other apparatus. Soldered or wire strapped connections shall only be inside electronic systems. Any wire wrapping shall be in accordance with IEC 60352.

| <b>Circuit</b>       | <b>Unit</b>     | <b>Value</b> |
|----------------------|-----------------|--------------|
| Power circuits (min) | mm <sup>2</sup> | 2.5          |
| Control circuits     | mm <sup>2</sup> | 2.5          |
| CT circuits (min)    | mm <sup>2</sup> | 4            |
| VT circuits (min)    | mm <sup>2</sup> | 2.5          |
| External wiring      | mm <sup>2</sup> | 2.5          |
| Other wiring         | mm <sup>2</sup> | 2.5          |

## Doors

The door shall be hinged and shall be provided with handles and external lock for locking facility. All hinges and locking elements shall be of heavy-duty, stainless steel or reinforced plastic pocket to prevent corrosion. Gasketing shall be suitable for the entire life of the switchgear considering the site operating conditions. Otherwise, metal to metal jointing shall be employed assuring the relevant degree of protection. Alternative door fixing solution may be proposed and are subject to BREB approval.

The doors shall be provided with stoppers. The edges of the doors shall be bent on both sides to assure proper fitting to the doorjambs to prevent misalignment. Steel pocket shall be provided on the inner surface of each door for drawings and manuals.

### (xvii) Corrosion Protection/Painting

For Corrosion Protection measures, reference shall be made to Standard Technical Specification. All hardware used in the assembly of the Switchgear must be either of corrosion proof material, or be hot dip galvanized. Circuit-breaker operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations and other ancillary equipment shall be accommodated in AluZinc(preferred)/anodized coated sheet aluminum vermin-proof and weatherproof cubicles. Where appropriate the cubicles may be free standing. Cubicles are to be painted with RAL 7044 & RAL 7032 color. A detailed Corrosion Protection/Painting description shall be submitted for approval by BREB.

## Technical Requirement of 33 kV Gas Insulated Switchgear and Control Equipment Line Feeder (Incoming & Outgoing) Switchgear Units

| Description                                           | Unit  | BREB's Requirement                                                                                                                                                                                                                        | Bidders Guaranteed Values |
|-------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Manufacturer's Name & Address                         |       | To be mentioned                                                                                                                                                                                                                           |                           |
| Model/ Type                                           |       | To be mentioned                                                                                                                                                                                                                           |                           |
| Commercial operation time of offered switchgear type  | Years | To be mentioned                                                                                                                                                                                                                           |                           |
| Applied Standard                                      |       | To be mentioned                                                                                                                                                                                                                           |                           |
| Country of Origin and Manufacture (Shall be the same) |       | UK/USA/EU/Japan/Canada/ Australia/ Switzerland /South Korea/Other eligible countries may be accepted where equivalent quality(Please see the instruction,Section-3)can be demonstrated(Acceptance of equivalency will depend on employer) |                           |
| Rated nominal voltage                                 | kV    | 33                                                                                                                                                                                                                                        |                           |
| Rated Voltage                                         | kV    | 36                                                                                                                                                                                                                                        |                           |
| Rated Frequency                                       | Hz    | 50                                                                                                                                                                                                                                        |                           |
| Installation                                          |       | Free Standing                                                                                                                                                                                                                             |                           |
| Rated Current for Main Bus                            | A     | 2000                                                                                                                                                                                                                                      |                           |
| Rated short time current                              | kA    | 31.5                                                                                                                                                                                                                                      |                           |
| Short time current rated duration                     | Sec.  | 3                                                                                                                                                                                                                                         |                           |
| <b>Circuit Breaker:</b>                               |       |                                                                                                                                                                                                                                           |                           |

|                                                                            |      |                                                            |  |
|----------------------------------------------------------------------------|------|------------------------------------------------------------|--|
| Type                                                                       |      | VCB                                                        |  |
| Class of Circuit Breaker (as per IEC)                                      |      | E2M2 or better                                             |  |
| Insulation media                                                           |      | SF6                                                        |  |
| Interrupting media                                                         |      | Vacuum                                                     |  |
| Vacuum Interrupter – Country of Origin and Manufacture (Shall be the same) |      | UK/USA/EU/Japan/Canada/ Australia/ Switzerland/South Korea |  |
| Vacuum Interrupter – Model                                                 |      | To be mentioned                                            |  |
| Guaranteed Nos. of operation for Vacuum Interrupter:                       |      |                                                            |  |
| a) at rated current switching                                              | Nos. | $\geq 30000$                                               |  |
| b) at short circuit current switching                                      | Nos. | $\geq 100$                                                 |  |

|                                                      |       |                        |  |
|------------------------------------------------------|-------|------------------------|--|
| Rated Voltage                                        | kV    | 36                     |  |
| Rated Current                                        | A     | 2000                   |  |
| Rated short circuit breaking current                 | kA    | 31.5                   |  |
| Rated duration of short circuit current              | Sec.  | 3                      |  |
| Rated short circuit making current                   | kA    | 80                     |  |
| Rated breaking time                                  | Cycle | < 3                    |  |
| Opening time                                         | ms    | < 60                   |  |
| Closing time                                         | ms    | ≤ 70                   |  |
| Contact resistance                                   | μΩ    | < 40                   |  |
| Rated operating sequence                             |       | 0-0.3sec-CO-3min-CO    |  |
| Control voltage                                      | V     | DC 110                 |  |
| AC Voltage for the Universal Motor for spring charge | V     | AC 180~250             |  |
| Power consumption of charging motor                  | W     | To be mentioned        |  |
| Power consumption of opening/trip coil               | W     | To be mentioned        |  |
| Number of Trip coils                                 | Nos.  | 2                      |  |
| Motor voltage for spring charge                      | V     | To be mentioned        |  |
| <b>Three Position Disconnect Switch:</b>             |       |                        |  |
| Type                                                 |       | To be mentioned        |  |
| Rated Voltage                                        | kV    | 36                     |  |
| Rated current                                        | A     | 2000                   |  |
| Rated short time current                             | kA    | 31.5                   |  |
| Short time current rated duration                    | Sec.  | 3                      |  |
| Switch positions                                     |       | Closed, Open, Earth    |  |
| Electrical and Mechanical interlock                  |       | As per IEC 62271-200   |  |
| Operation                                            |       | Both Motor and Manual  |  |
| <b>Current Transformer:</b>                          |       |                        |  |
| Type                                                 |       | To be mentioned        |  |
| Rated Voltage                                        | kV    | 36                     |  |
| Rated Current Ratio                                  | A     | 1200-600/1-1-1-1       |  |
| Accuracy class, Metering                             |       | 0.2S                   |  |
| Accuracy class, Protection                           |       | 5P20                   |  |
| Burden for metering                                  | VA    | 15 (for both CT ratio) |  |
| Burden for protection                                | VA    | 15 (for both CT ratio) |  |
| Extended Current Rating (metering)                   | %     | 120% of Rated current  |  |
| Instrument Security factor (metering)                |       | ≤ FS5                  |  |

|                                    |    |                                         |  |
|------------------------------------|----|-----------------------------------------|--|
| Accuracy Limit Factor (protection) |    | $\geq 20$                               |  |
| Rated frequency                    | Hz | 50                                      |  |
| Type of Winding                    |    |                                         |  |
| a) Primary                         |    | To be mentioned                         |  |
| b) Secondary                       |    | Quadruple (2 metering and 2 protection) |  |
| CT Rating Selection Calculations   |    | To be provided                          |  |

|                                                                                                 |     |                                                                              |  |
|-------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------|--|
| <b>Voltage Transformer (Applicable for Incoming Line VT and Bus VT):</b>                        |     |                                                                              |  |
| Type/Model                                                                                      |     | To be mentioned                                                              |  |
| Number of Phase                                                                                 |     | Single Phase                                                                 |  |
| Rated Primary Voltage                                                                           | kV  | $33/\sqrt{3}$                                                                |  |
| Rated Secondary Voltage                                                                         | V   | $110/\sqrt{3}$                                                               |  |
| Rated Burden, Secondary                                                                         | VA  | 20                                                                           |  |
| Accuracy class, Metering core                                                                   |     | 0.2                                                                          |  |
| Accuracy class, Protection core                                                                 |     | 3P                                                                           |  |
| Primary fuse protection                                                                         |     | Yes                                                                          |  |
| VT Rating Selection Calculations                                                                |     | To be provided                                                               |  |
| <b>SF6 Safety and Life:</b>                                                                     |     |                                                                              |  |
| SF6 Pressure:                                                                                   |     |                                                                              |  |
| a) Rated pressure at 20°C                                                                       | kPa | To be mentioned                                                              |  |
| b) Minimum functional pressure at 20°C                                                          | kPa | To be mentioned                                                              |  |
| c) Bursting Pressure                                                                            | kPa | To be mentioned                                                              |  |
| Gas Leakage Rate/year                                                                           |     | $\leq 0.1\%$                                                                 |  |
| Safety Indication                                                                               |     | To be incorporated                                                           |  |
| Capacitive Voltage Indicator (UK/USA/EU/Japan/Canada/Australia/Switzerland origin)              |     | For 3 phases in both the front and rear side of the panel (not plug-in type) |  |
| Gas compartment monitoring by Intelligent Gas Information System (For Each Gas Chamber/Section) |     | To be provided                                                               |  |
| Gas pressure Indication Meter                                                                   |     | To be provided                                                               |  |
| Gas Pressure Indication Alarm                                                                   |     | To be provided                                                               |  |
| Life / Endurance of Switchgear:                                                                 |     |                                                                              |  |
| a) Circuit Breakers                                                                             |     | As per IEC 62271-100                                                         |  |



|                                                                                                       |     |                                |  |
|-------------------------------------------------------------------------------------------------------|-----|--------------------------------|--|
| b) Disconnecter and Earthing Switches                                                                 |     | As per IEC 62271-102           |  |
| Alarm level for insulation                                                                            | kPa | To be mentioned                |  |
| Rated filling level for insulation                                                                    | kPa | To be mentioned                |  |
| Pressure relief device is integrated with each gas chamber                                            |     | Yes                            |  |
| Mimic diagram is depicted in front of switchgear panel                                                |     | Yes                            |  |
| Electrical and Mechanical interlock between Circuit breaker, isolator and earth switch                |     | Yes                            |  |
| Internal Arc Classification <i>Internal arc classification shall be supported by type test report</i> |     | IAC A-FLR as per IEC 62217-200 |  |
| <b>Insulation level:</b>                                                                              |     |                                |  |
| AC withstand voltage 1 min. dry                                                                       | kV  | 70                             |  |
| Impulse withstands, full wave                                                                         | kV  | 170                            |  |
| <b>Degree of Protection:</b>                                                                          |     |                                |  |

|                                                                                                                                                                     |                 |                                                                                                                |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------|--|
| Enclosure                                                                                                                                                           |                 | IP4X                                                                                                           |  |
| HV Compartment                                                                                                                                                      |                 | IP65                                                                                                           |  |
| LV Compartment                                                                                                                                                      |                 | IP40                                                                                                           |  |
| <b>Busbar:</b>                                                                                                                                                      |                 |                                                                                                                |  |
| Material                                                                                                                                                            |                 | HDHC Copper                                                                                                    |  |
| Shape                                                                                                                                                               |                 | To be mentioned                                                                                                |  |
| Cross Section                                                                                                                                                       | mm <sup>2</sup> | As per IEC62271                                                                                                |  |
| Nominal Current                                                                                                                                                     | A               | 2000                                                                                                           |  |
| Busbar Scheme                                                                                                                                                       |                 | Single Bus with Bus Sectionalizer within Gas                                                                   |  |
| Busbar Connection (Inter-panel)                                                                                                                                     |                 | The individual panel should be connected by the Plug-in /Continuous Bolted Type /Similar Arrangements bus bar. |  |
| Provision for Future Extension <i>Switchgear shall be designed for extension on both sides without requiring gas handling or causing outage to adjacent panels.</i> |                 | Yes                                                                                                            |  |
| <b>Accessories:</b>                                                                                                                                                 |                 |                                                                                                                |  |

|                                                                                                                                                       |     |                                                                                                                                                                                                                                           |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Cable Connection                                                                                                                                      |     | 3 x plug-in interface<br>(Compatible up to 500 mm <sup>2</sup> Cu Cable) for 2000A Circuit Breaker 2 x plug-in interface<br>(Compatible up to 500 mm <sup>2</sup> Cu Cable) for 1250A Circuit Breaker                                     |  |
| Test Socket                                                                                                                                           |     | For 3 phases                                                                                                                                                                                                                              |  |
| Voltage Transformer                                                                                                                                   |     | Single phase Plug in type (Only for Incoming Line VT and Bus VT)                                                                                                                                                                          |  |
| Surge Arrester                                                                                                                                        |     | Single phase Plug in type                                                                                                                                                                                                                 |  |
| GIS Termination Kits –<br>Manufacturer Name & Origin Country:<br><i>Shall be recommended by the GIS manufacturer for the offered switchgear type.</i> |     | UK/USA/EU/Japan/Canada/ Australia/ Switzerland /south korea/Other eligible countries may be accepted where equivalent quality(Please see the instruction,Section-3)can be demonstrated(Acceptance of equivalency will depend on employer) |  |
| <b>Dimension and Weight</b>                                                                                                                           |     |                                                                                                                                                                                                                                           |  |
| Height                                                                                                                                                | mm  | To be mentioned                                                                                                                                                                                                                           |  |
| Width                                                                                                                                                 | mm  | To be mentioned                                                                                                                                                                                                                           |  |
| Depth                                                                                                                                                 | mm  | To be mentioned                                                                                                                                                                                                                           |  |
| Weight including Circuit Breaker                                                                                                                      | Kg. | To be mentioned                                                                                                                                                                                                                           |  |
| <b>Type Test</b>                                                                                                                                      |     |                                                                                                                                                                                                                                           |  |
| List of performed type tests                                                                                                                          |     | To be mentioned                                                                                                                                                                                                                           |  |
| Type test certificates                                                                                                                                |     | To be submitted                                                                                                                                                                                                                           |  |
| Name & address of the internationally recognized                                                                                                      |     | To be mentioned                                                                                                                                                                                                                           |  |
| independent testing laboratory                                                                                                                        |     |                                                                                                                                                                                                                                           |  |

(xviii) **Bus Coupler (with Riser) Switchgear Units**

| Description                                                                | Unit  | BREB's Requirement                                                                                                                                                                                                                        |  |
|----------------------------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Manufacturer's Name & Address                                              |       | To be mentioned                                                                                                                                                                                                                           |  |
| Model/ Type                                                                |       | To be mentioned                                                                                                                                                                                                                           |  |
| Commercial operation time of offered switchgear type                       | Years | To be mentioned                                                                                                                                                                                                                           |  |
| Applied Standard                                                           |       | To be mentioned                                                                                                                                                                                                                           |  |
| Country of Origin and Manufacture (Shall be the same)                      |       | UK/USA/EU/Japan/Canada/ Australia/ Switzerland /South Korea/Other eligible countries may be accepted where equivalent quality(Please see the instruction,Section-3)can be demonstrated(Acceptance of equivalency will depend on employer) |  |
| Rated nominal voltage                                                      | kV    | 33                                                                                                                                                                                                                                        |  |
| Rated Voltage                                                              | kV    | 36                                                                                                                                                                                                                                        |  |
| Rated Frequency                                                            | Hz    | 50                                                                                                                                                                                                                                        |  |
| Installation                                                               |       | Free Standing                                                                                                                                                                                                                             |  |
| Rated Current for Main Bus                                                 | A     | 2000                                                                                                                                                                                                                                      |  |
| Rated short time current                                                   | kA    | 31.5                                                                                                                                                                                                                                      |  |
| Short time current rated duration                                          | Sec.  | 3                                                                                                                                                                                                                                         |  |
| <b>Circuit Breaker:</b>                                                    |       |                                                                                                                                                                                                                                           |  |
| Type                                                                       |       | VCB                                                                                                                                                                                                                                       |  |
| Class of Circuit Breaker (as per IEC)                                      |       | E2M2 or better                                                                                                                                                                                                                            |  |
| Insulation media                                                           |       | SF6                                                                                                                                                                                                                                       |  |
| Interrupting media                                                         |       | Vacuum                                                                                                                                                                                                                                    |  |
| Vacuum Interrupter – Country of Origin and Manufacture (Shall be the same) |       | UK/USA/EU/Japan/Canada/ Australia/ Switzerland                                                                                                                                                                                            |  |
| Vacuum Interrupter – Model                                                 |       | To be mentioned                                                                                                                                                                                                                           |  |
| Guaranteed Nos. of operation for Vacuum Interrupter:                       |       |                                                                                                                                                                                                                                           |  |
| a) at rated current switching                                              | Nos.  | ≥ 30000                                                                                                                                                                                                                                   |  |
| b) at short circuit current switching                                      | Nos.  | ≥ 100                                                                                                                                                                                                                                     |  |
| Rated Voltage                                                              | kV    | 36                                                                                                                                                                                                                                        |  |
| Rated Current                                                              | A     | 2000                                                                                                                                                                                                                                      |  |
| Rated short circuit breaking current                                       | kA    | 31.5                                                                                                                                                                                                                                      |  |
| Rated duration of short circuit current                                    | Sec.  | 3                                                                                                                                                                                                                                         |  |
| Rated short circuit making current                                         | kA    | 80                                                                                                                                                                                                                                        |  |
| Rated breaking time                                                        | Cycle | < 3                                                                                                                                                                                                                                       |  |
| Opening time                                                               | ms    | < 60                                                                                                                                                                                                                                      |  |
| Closing time                                                               | ms    | ≤ 70                                                                                                                                                                                                                                      |  |

|                          |             |                     |  |
|--------------------------|-------------|---------------------|--|
| Contact resistance       | $\mu\Omega$ | < 40                |  |
| Rated operating sequence |             | 0-0.3sec-CO-3min-CO |  |
| Control voltage          | V           | DC 110              |  |

|                                                                                                   |      |                                      |  |
|---------------------------------------------------------------------------------------------------|------|--------------------------------------|--|
| AC Voltage for the Universal Motor for spring charge                                              | V    | AC 180~260/230                       |  |
| Power consumption of charging motor                                                               | W    | To be mentioned                      |  |
| Power consumption of opening/trip coil                                                            | W    | To be mentioned                      |  |
| Number of Trip coils                                                                              | Nos. | 2                                    |  |
| Motor voltage for spring charge                                                                   | V    | To be mentioned                      |  |
| <b>Three Position Disconnect Switch:</b>                                                          |      |                                      |  |
| Type                                                                                              |      | To be mentioned                      |  |
| Rated Voltage                                                                                     | kV   | 36                                   |  |
| Rated current                                                                                     | A    | 2000                                 |  |
| Rated short time current                                                                          | kA   | 31.5                                 |  |
| Short time current rated duration                                                                 | Sec. | 3                                    |  |
| Switch positions                                                                                  |      | Closed, Open, Earth                  |  |
| Electrical and Mechanical interlock                                                               |      | As per IEC 62271-200                 |  |
| Operation                                                                                         |      | Both Motor and Manual                |  |
| <b>Current Transformer:</b>                                                                       |      |                                      |  |
| Type                                                                                              |      | To be mentioned                      |  |
| Rated Voltage                                                                                     | kV   | 36                                   |  |
| Rated Current Ratio                                                                               | A    | 1200-600/1-1                         |  |
| Accuracy class, Metering                                                                          |      | 0.2S                                 |  |
| Accuracy class, Protection                                                                        |      | 5P20                                 |  |
| Burden for metering                                                                               | VA   | 15 (for both CT ratio)               |  |
| Burden for protection                                                                             | VA   | 15 (for both CT ratio)               |  |
| Extended Current Rating (metering)                                                                | %    | 120% of Rated current                |  |
| Instrument Security factor (metering)                                                             |      | $\leq$ FS5                           |  |
| Accuracy Limit Factor (protection)                                                                |      | $\geq$ 20                            |  |
| Rated frequency                                                                                   | Hz   | 50                                   |  |
| Type of Winding                                                                                   |      |                                      |  |
| a) Primary                                                                                        |      | To be mentioned                      |  |
| b) Secondary                                                                                      |      | Double (1 metering and 1 protection) |  |
| CT Rating Selection Calculations <i>Contractor shall submit CT rating selection calculations.</i> |      | To be provided                       |  |
| <b>Voltage Transformer (Applicable for Incoming Line VT and Bus VT):</b>                          |      |                                      |  |
| Type/Model                                                                                        |      | To be mentioned                      |  |
| Number of Phase                                                                                   |      | Single Phase                         |  |

|                                  |    |                 |  |
|----------------------------------|----|-----------------|--|
| Rated Primary Voltage            | kV | 33/ $\sqrt{3}$  |  |
| Rated Secondary Voltage          | V  | 110/ $\sqrt{3}$ |  |
| Rated Burden, Secondary          | VA | 20              |  |
| Accuracy class, Metering core    |    | 0.2             |  |
| Accuracy class, Protection core  |    | 3P              |  |
| Primary fuse protection          |    | Yes             |  |
| VT Rating Selection Calculations |    | To be provided  |  |
| Type/Model                       |    | To be mentioned |  |
| Number of Phase                  |    | Single Phase    |  |

|                                                                                                                                                                                                                                                                                |     |                                                                              |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------|--|
| <b>SF6 Safety and Life:</b>                                                                                                                                                                                                                                                    |     |                                                                              |  |
| SF6 Pressure:                                                                                                                                                                                                                                                                  |     |                                                                              |  |
| a) Rated pressure at 20°C                                                                                                                                                                                                                                                      | kPa | To be mentioned                                                              |  |
| b) Minimum functional pressure at 20°C                                                                                                                                                                                                                                         | kPa | To be mentioned                                                              |  |
| c) Bursting Pressure                                                                                                                                                                                                                                                           | kPa | To be mentioned                                                              |  |
| Gas Leakage Rate/year                                                                                                                                                                                                                                                          |     | ≤0.1%                                                                        |  |
| Safety Indication                                                                                                                                                                                                                                                              |     | To be incorporated                                                           |  |
| Capacitive Voltage Indicator (UK/USA/EU/Japan/Canada/Australia/ Switzerland/ South Korea origin/Other eligible countries may be accepted where equivalent quality (Please see the instruction,Page:6-3)can be demonstrated(Acceptance of equivalency will depend on employer)) |     | For 3 phases in both the front and rear side of the panel (not plug-in type) |  |
| Gas compartment monitoring by Intelligent Gas Information System                                                                                                                                                                                                               |     | To be mentioned                                                              |  |
| Gas pressure Indication Meter                                                                                                                                                                                                                                                  |     | To be provided                                                               |  |
| Gas Pressure Indication Alarm                                                                                                                                                                                                                                                  |     | To be provided                                                               |  |
| Life / Endurance of Switchgear:                                                                                                                                                                                                                                                |     |                                                                              |  |
| a) Circuit Breakers                                                                                                                                                                                                                                                            |     | As per IEC 62271-100                                                         |  |
| b) Disconnect and Earthing Switches                                                                                                                                                                                                                                            |     | As per IEC 62271-102                                                         |  |
| Alarm level for insulation                                                                                                                                                                                                                                                     | kPa | To be mentioned                                                              |  |
| Rated filling level for insulation                                                                                                                                                                                                                                             | kPa | To be mentioned                                                              |  |
| Pressure relief device is integrated with each gas chamber                                                                                                                                                                                                                     |     | Yes                                                                          |  |
| Mimic diagram is depicted in front of switchgear panel                                                                                                                                                                                                                         |     | Yes                                                                          |  |

|                                                                                                                                                              |                 |                                                                                                                |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------|--|
| Electrical and Mechanical interlock between Circuit breaker, isolator and earth switch                                                                       |                 | Yes                                                                                                            |  |
| Internal Arc Classification<br><i>Internal arc classification shall be supported by type test report</i>                                                     |                 | IAC A-FLR as per IEC 62217-200                                                                                 |  |
| <b>Insulation level:</b>                                                                                                                                     |                 |                                                                                                                |  |
| AC withstand voltage 1 min. dry                                                                                                                              | kV              | 70                                                                                                             |  |
| Impulse withstands, full wave                                                                                                                                | kV              | 170                                                                                                            |  |
| <b>Degree of Protection:</b>                                                                                                                                 |                 |                                                                                                                |  |
| Enclosure                                                                                                                                                    |                 | IP4X                                                                                                           |  |
| HV Compartment                                                                                                                                               |                 | IP65                                                                                                           |  |
| LV Compartment                                                                                                                                               |                 | IP40                                                                                                           |  |
| <b>Busbar:</b>                                                                                                                                               |                 |                                                                                                                |  |
| Material                                                                                                                                                     |                 | HDHC Copper                                                                                                    |  |
| Shape                                                                                                                                                        |                 | To be mentioned                                                                                                |  |
| Cross Section                                                                                                                                                | mm <sup>2</sup> | As per IEC62271                                                                                                |  |
| Nominal Current                                                                                                                                              | A               | 2000                                                                                                           |  |
| Busbar Scheme                                                                                                                                                |                 | Single Bus with Bus Sectionalizer within Gas                                                                   |  |
| Busbar Connection (Inter-panel)                                                                                                                              |                 | The individual panel should be connected by the Plug-in /Continuous Bolted Type /Similar Arrangements bus bar. |  |
| Provision for Future Extension Switchgear shall be designed for extension on both sides without requiring gas handling or causing outage to adjacent panels. |                 | Yes                                                                                                            |  |
| <b>Dimension and Weight</b>                                                                                                                                  |                 |                                                                                                                |  |
| Height                                                                                                                                                       | mm              | To be mentioned                                                                                                |  |
| Width                                                                                                                                                        | mm              | To be mentioned                                                                                                |  |
| Depth                                                                                                                                                        | mm              | To be mentioned                                                                                                |  |
| Weight including Circuit Breaker                                                                                                                             | Kg.             | To be mentioned                                                                                                |  |
| <b>Type Test</b>                                                                                                                                             |                 |                                                                                                                |  |
| List of performed type tests                                                                                                                                 |                 | To be mentioned                                                                                                |  |
| Type test certificates                                                                                                                                       |                 | To be submitted                                                                                                |  |
| Name & address of the internationally recognized independent testing laboratory                                                                              |                 | To be mentioned                                                                                                |  |

**33/11.55kV Transformer Feeder Switchgear Units**

| <b>Description</b>                                                         | <b>Unit</b> | <b>BREB's Requirement</b>                                                                                                                                                                                                                 | <b>Bidders Guranteed values</b> |
|----------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Manufacturer's Name & Address                                              |             | To be mentioned                                                                                                                                                                                                                           |                                 |
| Model/ Type                                                                |             | To be mentioned                                                                                                                                                                                                                           |                                 |
| Commercial operation time of offered switchgear type                       | Years       | To be mentioned                                                                                                                                                                                                                           |                                 |
| Applied Standard                                                           |             | To be mentioned                                                                                                                                                                                                                           |                                 |
| Country of Origin and Manufacture (Shall be the same)                      |             | UK/USA/EU/Japan/Canada/ Australia/ Switzerland /South Korea/Other eligible countries may be accepted where equivalent quality(Please see the instruction,Section-3)can be demonstrated(Acceptance of equivalency will depend on employer) |                                 |
| Rated nominal voltage                                                      | kV          | 33                                                                                                                                                                                                                                        |                                 |
| Rated Voltage                                                              | kV          | 36                                                                                                                                                                                                                                        |                                 |
| Rated Frequency                                                            | Hz          | 50                                                                                                                                                                                                                                        |                                 |
| Installation                                                               |             | Free Standing                                                                                                                                                                                                                             |                                 |
| Rated Current for Main Bus                                                 | A           | 2000                                                                                                                                                                                                                                      |                                 |
| Rated short time current                                                   | kA          | 31.5                                                                                                                                                                                                                                      |                                 |
| Short time current rated duration                                          | Sec.        | 3                                                                                                                                                                                                                                         |                                 |
| <b>Circuit Breaker:</b>                                                    |             |                                                                                                                                                                                                                                           |                                 |
| Type                                                                       |             | VCB                                                                                                                                                                                                                                       |                                 |
| Class of Circuit Breaker (as per IEC)                                      |             | E2M2 or better                                                                                                                                                                                                                            |                                 |
| Insulation media                                                           |             | SF6                                                                                                                                                                                                                                       |                                 |
| Interrupting media                                                         |             | Vacuum                                                                                                                                                                                                                                    |                                 |
| Vacuum Interrupter – Country of Origin and Manufacture (Shall be the same) |             | UK/USA/EU/Japan/Canada/ Australia/ Switzerland/                                                                                                                                                                                           |                                 |
| Vacuum Interrupter – Model                                                 |             | To be mentioned                                                                                                                                                                                                                           |                                 |
| Guaranteed Nos. of operation for Vacuum Interrupter:                       |             |                                                                                                                                                                                                                                           |                                 |
| a) at rated current switching                                              | Nos.        | ≥ 30000                                                                                                                                                                                                                                   |                                 |
| b) at short circuit current switching                                      | Nos.        | ≥ 100                                                                                                                                                                                                                                     |                                 |
| Rated Voltage                                                              | kV          | 36                                                                                                                                                                                                                                        |                                 |
| Rated Current                                                              | A           | 1250                                                                                                                                                                                                                                      |                                 |
| Rated short circuit breaking current                                       | kA          | 31.5                                                                                                                                                                                                                                      |                                 |

|                                         |       |     |  |
|-----------------------------------------|-------|-----|--|
| Rated duration of short circuit current | Sec.  | 3   |  |
| Rated short circuit making current      | kA    | 80  |  |
| Rated breaking time                     | Cycle | < 3 |  |

|                                                      |      |                        |  |
|------------------------------------------------------|------|------------------------|--|
| Opening time                                         | ms   | < 60                   |  |
| Closing time                                         | ms   | ≤ 70                   |  |
| Contact resistance                                   | μΩ   | < 40                   |  |
| Rated operating sequence                             |      | 0-0.3sec-CO-3min-CO    |  |
| Control voltage                                      | V    | DC 110                 |  |
| AC Voltage for the Universal Motor for spring charge | V    | AC 180~260/230         |  |
| Power consumption of charging motor                  | W    | To be mentioned        |  |
| Power consumption of opening/trip coil               | W    | To be mentioned        |  |
| Number of Trip coils                                 | Nos. | 2                      |  |
| Motor voltage for spring charge                      | V    | To be mentioned        |  |
| <b>Three Position Disconnect Switch:</b>             |      |                        |  |
| Type                                                 |      | To be mentioned        |  |
| Rated Voltage                                        | kV   | 36                     |  |
| Rated current                                        | A    | 2000                   |  |
| Rated short time current                             | kA   | 31.5                   |  |
| Short time current rated duration                    | Sec. | 3                      |  |
| Switch positions                                     |      | Closed, Open, Earth    |  |
| Electrical and Mechanical interlock                  |      | As per IEC 62271-200   |  |
| Operation                                            |      | Both Motor and Manual  |  |
| <b>Current Transformer:</b>                          |      |                        |  |
| Type                                                 |      | To be mentioned        |  |
| Rated Voltage                                        | kV   | 36                     |  |
| Rated Current Ratio                                  | A    | 800-400/1-1-1-1        |  |
| Accuracy class, Metering                             |      | 0.2S                   |  |
| Accuracy class, Protection                           |      | 5P20                   |  |
| Burden for metering                                  | VA   | 15 (for both CT ratio) |  |
| Burden for protection                                | VA   | 15 (for both CT ratio) |  |
| Extended Current Rating (metering)                   | %    | 120% of Rated current  |  |
| Instrument Security factor (metering)                |      | ≤ FS5                  |  |
| Accuracy Limit Factor (protection)                   |      | ≥ 20                   |  |
| Rated frequency                                      | Hz   | 50                     |  |
| Type of Winding                                      |      |                        |  |
| a) Primary                                           |      | To be mentioned        |  |



|                                                                                                                                                                                                                                                                      |     |                                                                              |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------|--|
| b) Secondary                                                                                                                                                                                                                                                         |     | Quadruple (2 metering and 2 protection)                                      |  |
| CT Rating Selection<br>Calculations <i>Contractor shall submit CT rating selection calculations.</i>                                                                                                                                                                 |     | To be provided                                                               |  |
| <b>Voltage Transformer (Applicable for Incoming Line VT and Bus VT):</b>                                                                                                                                                                                             |     |                                                                              |  |
| Type/Model                                                                                                                                                                                                                                                           |     | To be mentioned                                                              |  |
| Number of Phase                                                                                                                                                                                                                                                      |     | Single Phase                                                                 |  |
| Rated Primary Voltage                                                                                                                                                                                                                                                | kV  | 33/√3                                                                        |  |
| Rated Secondary Voltage                                                                                                                                                                                                                                              | V   | 110/√3                                                                       |  |
| Rated Burden, Secondary                                                                                                                                                                                                                                              | VA  | 20                                                                           |  |
| Accuracy class, Metering core                                                                                                                                                                                                                                        |     | 0.2                                                                          |  |
| Accuracy class, Protection core                                                                                                                                                                                                                                      |     | 3P                                                                           |  |
| Primary fuse protection                                                                                                                                                                                                                                              |     | Yes                                                                          |  |
| VT Rating Selection<br>Calculations                                                                                                                                                                                                                                  |     | To be provided                                                               |  |
| Type/Model                                                                                                                                                                                                                                                           |     | To be mentioned                                                              |  |
| Number of Phase                                                                                                                                                                                                                                                      |     | Single Phase                                                                 |  |
| <b>SF6 Safety and Life:</b>                                                                                                                                                                                                                                          |     |                                                                              |  |
| SF6 Pressure:                                                                                                                                                                                                                                                        |     |                                                                              |  |
| a) Rated pressure at 20°C                                                                                                                                                                                                                                            | kPa | To be mentioned                                                              |  |
| b) Minimum functional pressure at 20°C                                                                                                                                                                                                                               | kPa | To be mentioned                                                              |  |
| c) Bursting Pressure                                                                                                                                                                                                                                                 | kPa | To be mentioned                                                              |  |
| Gas Leakage Rate/year                                                                                                                                                                                                                                                |     | ≤0.1%                                                                        |  |
| Safety Indication                                                                                                                                                                                                                                                    |     | To be incorporated                                                           |  |
| Capacitive Voltage Indicator<br>(UK/USA/EU/Japan/Canada/Australia/ Switzerland origin/Other eligible countries may be accepted where equivalent quality(Please see the instruction,Page:6-3)can be demonstrated(Acceptance of equivalency will dependo on employer)) |     | For 3 phases in both the front and rear side of the panel (not plug-in type) |  |
| Gas compartment monitoring by Intelligent Gas Information System                                                                                                                                                                                                     |     | To be mentioned                                                              |  |
| Gas pressure Indication Meter                                                                                                                                                                                                                                        |     | To be provided                                                               |  |
| Gas Pressure Indication Alarm                                                                                                                                                                                                                                        |     | To be provided                                                               |  |
| Life / Endurance of Switchgear:                                                                                                                                                                                                                                      |     |                                                                              |  |
| a) Circuit Breakers                                                                                                                                                                                                                                                  |     | As per IEC 62271-100                                                         |  |
| b) Disconnecter and Earthing Switches                                                                                                                                                                                                                                |     | As per IEC 62271-102                                                         |  |

|                                                                                                                                                                        |                 |                                                                                                                |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------|--|
| Alarm level for insulation                                                                                                                                             | kPa             | To be mentioned                                                                                                |  |
| Rated filling level for insulation                                                                                                                                     | kPa             | To be mentioned                                                                                                |  |
| Pressure relief device is integrated with each gas chamber                                                                                                             |                 | Yes                                                                                                            |  |
| Mimic diagram is depicted in front of switchgear panel                                                                                                                 |                 | Yes                                                                                                            |  |
| Electrical and Mechanical interlock between Circuit breaker, isolator and earth switch                                                                                 |                 | Yes                                                                                                            |  |
| Internal Arc Classification<br><i>Internal arc classification shall be supported by type test report</i>                                                               |                 | IAC A-FLR as per IEC 62217-200                                                                                 |  |
| <b>Insulation level:</b>                                                                                                                                               |                 |                                                                                                                |  |
| AC withstand voltage 1 min. dry                                                                                                                                        | kV              | 70                                                                                                             |  |
| Impulse withstands, full wave                                                                                                                                          | kV              | 170                                                                                                            |  |
| <b>Degree of Protection:</b>                                                                                                                                           |                 |                                                                                                                |  |
| Enclosure                                                                                                                                                              |                 | IP4X                                                                                                           |  |
| HV Compartment                                                                                                                                                         |                 | IP65                                                                                                           |  |
| LV Compartment                                                                                                                                                         |                 | IP40                                                                                                           |  |
| <b>Busbar:</b>                                                                                                                                                         |                 |                                                                                                                |  |
| Material                                                                                                                                                               |                 | HDHC Copper                                                                                                    |  |
| Shape                                                                                                                                                                  |                 | To be mentioned                                                                                                |  |
| Cross Section                                                                                                                                                          | mm <sup>2</sup> | As per IEC62271                                                                                                |  |
| Nominal Current                                                                                                                                                        | A               | 2000                                                                                                           |  |
| Busbar Scheme                                                                                                                                                          |                 | Single Bus with Bus Sectionalizer within Gas                                                                   |  |
| Busbar Connection (Inter-panel)                                                                                                                                        |                 | The individual panel should be connected by the Plug-in /Continuous Bolted Type /Similar Arrangements bus bar. |  |
| Provision for Future Extension<br><i>Switchgear shall be designed for extension on both sides without requiring gas handling or causing outage to adjacent panels.</i> |                 | Yes                                                                                                            |  |
| <b>Accessories:</b>                                                                                                                                                    |                 |                                                                                                                |  |
| Cable Connection                                                                                                                                                       |                 | 2 x plug-in interface (Compatible up to 500 mm <sup>2</sup> Cu Cable) for 1250A Circuit Breaker                |  |
| Test Socket                                                                                                                                                            |                 | For 3 phases                                                                                                   |  |

|                                                                                                                                                                  |     |                                                                                                                                                                                                                                                                      |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Voltage Transformer                                                                                                                                              |     | Single phase Plug in type<br>(Only for Incoming Line VT<br>and Bus VT)                                                                                                                                                                                               |  |
| Surge Arrester                                                                                                                                                   |     | Single phase Plug in type                                                                                                                                                                                                                                            |  |
| GIS Termination Kits –<br>Manufacturer Name & Origin<br>Country:<br><i>Shall be recommended by<br/>the GIS manufacturer for the<br/>offered switchgear type.</i> |     | UK/USA/EU/Japan/Canada/<br>Australia/ Switzerland<br>/South Korea/Other eligible<br>countries may be accepted<br>where equivalent<br>quality(Please see the<br>instruction,Page:6-3)can be<br>demonstrated(Acceptance of<br>equivalency<br>will dependo on employer) |  |
| <b>Dimension and Weight</b>                                                                                                                                      |     |                                                                                                                                                                                                                                                                      |  |
| Height                                                                                                                                                           | mm  | To be mentioned                                                                                                                                                                                                                                                      |  |
| Width                                                                                                                                                            | mm  | To be mentioned                                                                                                                                                                                                                                                      |  |
| Depth                                                                                                                                                            | mm  | To be mentioned                                                                                                                                                                                                                                                      |  |
| Weight including Circuit<br>Breaker                                                                                                                              | Kg. | To be mentioned                                                                                                                                                                                                                                                      |  |
| <b>Type Test</b>                                                                                                                                                 |     |                                                                                                                                                                                                                                                                      |  |
| List of performed type tests                                                                                                                                     |     | To be mentioned                                                                                                                                                                                                                                                      |  |
| Type test certificates                                                                                                                                           |     | To be submitted                                                                                                                                                                                                                                                      |  |
| Name & address of the<br>internationally recognized<br>independent testing<br>laboratory                                                                         |     | To be mentioned                                                                                                                                                                                                                                                      |  |



**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****Design of Panels for 33 kV CRP**

| <b>Description</b>              | <b>Unit</b> | <b>BREB's Requirement</b>                                                                                                                     |  |
|---------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--|
| CRP Manufacturer's Name         |             | To be mentioned                                                                                                                               |  |
| Country of Origin               |             | To be mentioned                                                                                                                               |  |
| Type of Cubicle                 |             | Simplex                                                                                                                                       |  |
| Degree of Protection            |             | IP4X                                                                                                                                          |  |
| Dimension (W×D×H)               | mm          | To be mentioned                                                                                                                               |  |
| Painting Quality                |             | To be mentioned                                                                                                                               |  |
| Panel Interior Color            |             | To be mentioned                                                                                                                               |  |
| Panel Exterior Color            |             | To be mentioned                                                                                                                               |  |
| Panel Base Frame Color          |             | To be mentioned                                                                                                                               |  |
| Thickness of Panel Materials    | mm          | To be mentioned                                                                                                                               |  |
| Panel Earth Bar Thickness (W×D) | mm          | To be mentioned                                                                                                                               |  |
| Panel Earth Bar Material        |             | Tinned Copper                                                                                                                                 |  |
| Mimic for Bus & Circuit         |             | To be mentioned                                                                                                                               |  |
| Wiring for DC Circuit           |             | Multi Stranded 1100V Grade Flexible PVC Grey/Black 2.5 mm Wire                                                                                |  |
| Wiring for CT Circuit           |             | Multi Stranded 1100V Grade Flexible PVC Insulated Red, Yellow, Blue & Black Color Wire for Phase & Neutral and should be minimum 4 mm cable   |  |
| Wiring for PT Circuit           |             | Multi Stranded 1100V Grade Flexible PVC Insulated Red, Yellow, Blue & Black Color Wire for Phase & Neutral and should be minimum 2.5 mm cable |  |
| Ferrule                         |             | To be Mentioned                                                                                                                               |  |



### 33 kV CONTROL RELAY AND ENERGY METERING PANEL

#### 33kV INCOMING/OUTGOING FEEDER

| Description                                              | Unit           | BREB's Requirement                                                                                                                                                                                                                                                                             |    |
|----------------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>PROTECTION (OVER CURRENT &amp; EARTH FAULT RELAY)</b> |                |                                                                                                                                                                                                                                                                                                |    |
| Manufacturer's Name & Country                            | -              | Siemens (Germany)/ GE (USA/UK) ABB (Sweden/Switzerland/Finland)                                                                                                                                                                                                                                |    |
| Type of relay                                            | -              | Numerical Programmable with built-in display                                                                                                                                                                                                                                                   |    |
| Range setting                                            |                |                                                                                                                                                                                                                                                                                                |    |
| a) Phase element of current                              | % of CT rating | 5% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| b) Earth fault element of current                        |                | 1% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| c) Time Multiplier Setting (TMS)                         |                | 0.025 to at least 1.5 (Step Size 0.005)                                                                                                                                                                                                                                                        |    |
| Ranges of timing at DMT                                  | Sec            | 0-100 (with 1ms interval)                                                                                                                                                                                                                                                                      |    |
| Language                                                 |                | English                                                                                                                                                                                                                                                                                        |    |
| Relay Auxiliary Voltage                                  | V              | Minimum 88-250V DC and Minimum 115-250V AC                                                                                                                                                                                                                                                     |    |
| Nominal Current                                          | A              | Operable in 1A & 5A (User Settable)                                                                                                                                                                                                                                                            |    |
| Minimum No of LEDs                                       | Nos            | 10 (Programmable)                                                                                                                                                                                                                                                                              |    |
| HMI                                                      |                | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                                               |    |
| Software Requirement                                     |                | a) Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>b) Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license with probe/cable. | c) |
| Event Record & Oscillographic Disturbance Records        |                | Event recorder should keep at least 20 Nos previous records and disturbance recorder should handle all                                                                                                                                                                                         |    |

|                                                                                             |      |                                             |  |
|---------------------------------------------------------------------------------------------|------|---------------------------------------------|--|
|                                                                                             |      | analogue channels and binary channels       |  |
| Standard Protocol                                                                           | -    | IEC 61850                                   |  |
| Protection Feature                                                                          |      | Non-directional & Directional (if required) |  |
| Test Terminal Block (TTB) for OC & EF Relay (incl. male and female part)                    |      | Yes                                         |  |
| Standard                                                                                    |      | IEC 60255                                   |  |
| Bay control unit should have available                                                      | -    | Yes                                         |  |
| Minimum No of Binary Input                                                                  | Nos. | 32                                          |  |
| Minimum No of Binary Output                                                                 | Nos. | 18                                          |  |
| IEC 61850 communication Protocol Supported                                                  |      | To be mentioned                             |  |
| Sync Check function                                                                         |      | To be mentioned                             |  |
| U, I, P, Q, S, f, PF monitoring                                                             |      | Yes                                         |  |
| No of Communication Ports (rear) (Minimum 1 Optical Ports with redundancy must be provided) |      | To be mentioned                             |  |
| <b>Trip Relay (Separate Relay for each Numerical Relay)</b>                                 |      |                                             |  |

|                                                                                 |      |                                               |  |
|---------------------------------------------------------------------------------|------|-----------------------------------------------|--|
| Manufacturer's Name                                                             |      | To be mentioned                               |  |
| Place of Manufacture                                                            |      | UK/USA/EU/Japan/Canada/Australia/ Switzerland |  |
| Manufacturer's Model Number                                                     |      | To be mentioned                               |  |
| Type of Relay                                                                   |      | To be mentioned                               |  |
| Maximum Operating Time                                                          | ms   | 10                                            |  |
| Minimum No of Contact (NO + NC)                                                 | Nos  | 6 + 6                                         |  |
| Hand & Electrical reset mechanism                                               |      | Yes                                           |  |
| Rated voltage                                                                   | V DC | 88-125V                                       |  |
| <b>Trip Circuit Supervision (TCS) Relay (Separate Relay for each trip coil)</b> |      |                                               |  |
| Manufacturer's Name                                                             |      | Siemens/ABB/Alstom/GE                         |  |
| Manufacturer's Model Number                                                     |      | To be mentioned                               |  |



|                                                                              |      |                                                                                                                                                         |  |
|------------------------------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Type of Relay                                                                |      | To be mentioned                                                                                                                                         |  |
| Design                                                                       |      | Modular type                                                                                                                                            |  |
| <b>Ampere Meters</b>                                                         |      |                                                                                                                                                         |  |
| Manufacturer's Name                                                          |      | Siemens/ABB/GE/C<br>EWE/S<br>chlumb<br>erger/<br>AEG/Al<br>stom                                                                                         |  |
| Manufacturer's Model Number                                                  |      | To be mentioned                                                                                                                                         |  |
| Type of meter                                                                |      | Digital                                                                                                                                                 |  |
| Class of accuracy                                                            |      | 0.5                                                                                                                                                     |  |
| Separate meter for each phase                                                |      | Yes                                                                                                                                                     |  |
| Instantaneous rated current                                                  |      | To be mentioned                                                                                                                                         |  |
| ISF                                                                          |      | Minimum 10                                                                                                                                              |  |
| <b>Volt Meters with Selector Switch</b>                                      |      |                                                                                                                                                         |  |
| Manufacturer's Name                                                          |      | Siemens/ABB/GE/C<br>EWE/S<br>chlumb<br>erger/<br>AEG/Al<br>stom                                                                                         |  |
| Manufacturer's Model Number                                                  |      | To be mentioned                                                                                                                                         |  |
| Type of meter                                                                |      | Digital                                                                                                                                                 |  |
| Class of accuracy                                                            |      | 0.5                                                                                                                                                     |  |
| <b>Multifunction Meter (kW, kWh, kVARh, Voltage, Current, PF, Frequency)</b> |      |                                                                                                                                                         |  |
| Manufacturer's name & Country                                                |      | Siemens<br>(Germany/Switzerland)/Alst<br>om (UK)/ABB<br>(Finland/Switzerland)/AEG<br>(Germany)/Schlumberger<br>(USA)/CEWE (UK/Italy)                    |  |
| Model Number                                                                 | -    | To be mentioned                                                                                                                                         |  |
| Number of Meters                                                             | Nos. | Multifunction meter<br>containing (3 nos Ammeter,<br>3 nos voltmeter, 1 nos kW<br>meter, 1 nos kVAR meter, 1<br>nos PF meter, 1 nos<br>frequency meter) |  |
| Type of meter                                                                | -    | Digital                                                                                                                                                 |  |
| Class of accuracy                                                            | -    | 0.2                                                                                                                                                     |  |
| Export & Import Metering                                                     |      | Export & Import                                                                                                                                         |  |
| <b>Multi tariff programmable Energy meter (kWh Meter)</b>                    |      |                                                                                                                                                         |  |

|                               |      |                                                                                                                                                     |  |
|-------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Manufacturer's name & Country |      | Siemens<br>(Germany/Switzerland)/Alstom (UK)/ABB<br>(Sweden)/AEG (Germany)/Schlumberger<br>(USA)/Landis Gyr<br>(Switzerland/Greece)/CEWE (UK/Italy) |  |
| Model Number                  | -    | To be mentioned                                                                                                                                     |  |
| Number of KWh Meters          | Nos. | 1                                                                                                                                                   |  |

|                                               |          |                                                                                                                                                                                                                                                                                               |  |
|-----------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Class of accuracy                             | -        | 0.2S                                                                                                                                                                                                                                                                                          |  |
| Installation                                  |          | Indoor installation                                                                                                                                                                                                                                                                           |  |
| Number of element                             |          | 3 (Three)                                                                                                                                                                                                                                                                                     |  |
| Nominal Voltage                               | V        | 110                                                                                                                                                                                                                                                                                           |  |
| Construction/connection                       |          | 3-Phase 4-wire solidly grounded neutral                                                                                                                                                                                                                                                       |  |
| Export & Import Metering                      |          | Export & Import                                                                                                                                                                                                                                                                               |  |
| Nominal Rated Current                         | A        | Both 1A and 5A                                                                                                                                                                                                                                                                                |  |
| Type of the meter                             |          | Numerical Programmable, Multifunction with accuracy Class 0.2S, Load profile, instrumentation profile for minimum 1 yr with an interval of 30 min, software for protection and optical probe for data download as per IEC with provision of communication port automatic meter reading (AMR). |  |
| Starting Current                              | mA       | 0.1% of Nominal Current                                                                                                                                                                                                                                                                       |  |
| Losses at Nominal Load                        |          |                                                                                                                                                                                                                                                                                               |  |
| a) Current Circuit                            | W, VA    | To be mentioned                                                                                                                                                                                                                                                                               |  |
| b) Voltage Circuit                            | W, VA    | To be mentioned                                                                                                                                                                                                                                                                               |  |
| Meter Constant                                | Imp./kWh | To be mentioned                                                                                                                                                                                                                                                                               |  |
| Integration Period                            |          | 30 (Thirty) Minutes                                                                                                                                                                                                                                                                           |  |
| Battery Service life and shelf Life (minimum) | Years    | 10 (ten) & 15 (fifteen)                                                                                                                                                                                                                                                                       |  |
| Meter Service Life (Min)                      | Years    | 15 (fifteen)                                                                                                                                                                                                                                                                                  |  |
| Meter sealing condition                       |          | Hermetically or Ultrasonic welded (means break to open)                                                                                                                                                                                                                                       |  |
| Memory Storage                                | MB       |                                                                                                                                                                                                                                                                                               |  |
| i) No of Power Interruption with Date & Time  |          | Yes                                                                                                                                                                                                                                                                                           |  |

|                                                                        |      |                                                        |  |
|------------------------------------------------------------------------|------|--------------------------------------------------------|--|
| ii) Latest Power Failure-Time & Date                                   |      | Yes                                                    |  |
| iii) Event logs                                                        |      | Yes                                                    |  |
| iv) Cumulative kWh, kVARh (Q1 + Q4)<br>Reading for previous two months |      | Yes                                                    |  |
| v) Load profile with 30 min interval at least 01 (One) year for:       |      |                                                        |  |
| a) kWh, kVARh (Q1+Q4)                                                  |      | Yes                                                    |  |
| b) Phase Voltage or Vh                                                 |      | Yes                                                    |  |
| c) Phase Amps or Ah                                                    |      | Yes                                                    |  |
| Communication Facilities                                               |      | RS 232, RS 485, RJ45, GSM-GPRS and Modbus or IEC 61850 |  |
| GSM-GPRS Modem                                                         |      | Plug and Play 4G Communication Module                  |  |
| Optical Probe & TTB(incl. male & female part)                          |      | To be provided                                         |  |
| <b>Annunciator</b>                                                     |      |                                                        |  |
| Manufacturer's Name                                                    |      | To be mentioned                                        |  |
| Country of Origin                                                      |      | To be mentioned                                        |  |
| Manufacturer's Model Number                                            |      | To be mentioned                                        |  |
| Windows                                                                | Nos. | Minimum 24                                             |  |
| Built in buzzer and buttons for accept,                                |      | Yes                                                    |  |

|                                                                                  |             |                                            |  |
|----------------------------------------------------------------------------------|-------------|--------------------------------------------|--|
| mute, test, reset, etc.                                                          |             |                                            |  |
| <b>Control Switch</b>                                                            |             |                                            |  |
| Manufacturer's Name                                                              |             | To be mentioned                            |  |
| Country of Origin                                                                |             | To be mentioned                            |  |
| Manufacturer's Model Number                                                      |             | To be mentioned                            |  |
| Separate Discrepancy switch for CB on/off and Local Remote (L/R) selector switch |             | Yes                                        |  |
| 1 (One) nos. breaker Emergency trip                                              |             | To be provided                             |  |
| Mounting of Relays and Meters                                                    |             | All Relay and Meter shall be flush mounted |  |
| <b>33kV BUS COUPLER (WITH RISER)</b>                                             |             |                                            |  |
| <b>Description</b>                                                               | <b>Unit</b> | <b>BREB's Requirement</b>                  |  |
| <b>PROTECTION (OVER CURRENT &amp; EARTH FAULT RELAY)</b>                         |             |                                            |  |

|                                                   |                |                                                                                                                                                                                                                                                                                                |    |
|---------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Manufacturer's Name & Country                     | -              | Siemens (Germany)/GE (USA/UK) ABB (Sweden/Switzerland and/Finland)                                                                                                                                                                                                                             |    |
| Type of relay                                     | -              | Numerical Programmable with built-in display                                                                                                                                                                                                                                                   |    |
| Range setting                                     |                |                                                                                                                                                                                                                                                                                                |    |
| a) Phase element of current                       | % of CT rating | 5% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| b) Earth fault element of current                 |                | 1% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| c) Time Multiplier Setting (TMS)                  |                | 0.025 to at least 1.5 (Step Size 0.005)                                                                                                                                                                                                                                                        |    |
| Ranges of timing at DMT                           | Sec            | 0-100 (with 1ms interval)                                                                                                                                                                                                                                                                      |    |
| Language                                          |                | English                                                                                                                                                                                                                                                                                        |    |
| Relay Auxiliary Voltage                           | V              | Minimum 88-250V DC and Minimum 115-250V AC                                                                                                                                                                                                                                                     |    |
| Nominal Current                                   | A              | Operable in 1A & 5A (User Settable)                                                                                                                                                                                                                                                            |    |
| Minimum No of LEDs                                | Nos            | 10 (Programmable)                                                                                                                                                                                                                                                                              |    |
| HMI                                               |                | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                                               |    |
| Software Requirement                              |                | a) Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>b) Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license with probe/cable. | c) |
| Event Record & Oscillographic Disturbance Records |                | Event recorder should keep at least 20 Nos previous records and disturbance recorder should handle all analogue channels and binary channels                                                                                                                                                   |    |
| Standard Protocol                                 | -              | IEC 61850                                                                                                                                                                                                                                                                                      |    |
| Protection Feature                                |                | Non-directional & Directional (if required)                                                                                                                                                                                                                                                    |    |
| Test Terminal Block (TTB) for OC & EF             |                | Yes                                                                                                                                                                                                                                                                                            |    |

|                                        |      |           |  |
|----------------------------------------|------|-----------|--|
| Relay (incl. male and female part)     |      |           |  |
| Standard                               |      | IEC 60255 |  |
| Bay control unit should have available | -    | Yes       |  |
| Minimum No of Binary Input             | Nos. | 32        |  |
| Minimum No of Binary Output            | Nos. | 18        |  |

|                                                                                             |      |                                                             |  |
|---------------------------------------------------------------------------------------------|------|-------------------------------------------------------------|--|
| IEC 61850 communication Protocol Supported                                                  |      | To be mentioned                                             |  |
| Sync Check function                                                                         |      | To be mentioned                                             |  |
| U, I, P, Q, S, f, PF monitoring                                                             |      | Yes                                                         |  |
| No of Communication Ports (rear) (Minimum 1 Optical Ports with redundancy must be provided) |      | To be mentioned                                             |  |
| <b>Trip Relay (Separate Relay for each Numerical Relay)</b>                                 |      |                                                             |  |
| Manufacturer's Name                                                                         |      | To be mentioned                                             |  |
| Place of Manufacture                                                                        |      | UK/USA/EU/Japan/Canada/Australia/ Switzerland               |  |
| Manufacturer's Model Number                                                                 |      | To be mentioned                                             |  |
| Type of Relay                                                                               |      | To be mentioned                                             |  |
| Maximum Operating Time                                                                      | ms   | 10                                                          |  |
| Minimum No of Contact (NO + NC)                                                             | Nos  | 6 + 6                                                       |  |
| Hand & Electrical reset mechanism                                                           |      | Yes                                                         |  |
| Rated voltage                                                                               | V DC | 88-125V                                                     |  |
| <b>Trip Circuit Supervision (TCS) Relay (Separate Relay for each trip coil)</b>             |      |                                                             |  |
| Manufacturer's Name                                                                         |      | Siemens/ABB/Alstom/GE                                       |  |
| Manufacturer's Model Number                                                                 |      | To be mentioned                                             |  |
| Type of Relay                                                                               |      | To be mentioned                                             |  |
| Design                                                                                      |      | Modular type                                                |  |
| <b>Ampere Meters</b>                                                                        |      |                                                             |  |
| Manufacturer's Name                                                                         |      | Siemens/ABB/GE/C<br>EWE/S<br>chlumberger/<br>AEG/Al<br>stom |  |
| Manufacturer's Model Number                                                                 |      | To be mentioned                                             |  |

|                                                                 |      |                                                                 |  |
|-----------------------------------------------------------------|------|-----------------------------------------------------------------|--|
| Type of meter                                                   |      | Digital                                                         |  |
| Class of accuracy                                               |      | 0.5                                                             |  |
| Separate meter for each phase                                   |      | Yes                                                             |  |
| Instantaneous rated current                                     |      | To be mentioned                                                 |  |
| ISF                                                             |      | Minimum 10                                                      |  |
| <b>Volt Meters with Selector Switch</b>                         |      |                                                                 |  |
| Manufacturer's Name                                             |      | Siemens/ABB/GE/C<br>EWE/S<br>chlumb<br>erger/<br>AEG/AI<br>stom |  |
| Manufacturer's Model Number                                     |      | To be mentioned                                                 |  |
| Type of meter                                                   |      | Digital                                                         |  |
| Class of accuracy                                               |      | 0.5                                                             |  |
| <b>Annunciator</b>                                              |      |                                                                 |  |
| Manufacturer's Name                                             |      | To be mentioned                                                 |  |
| Country of Origin                                               |      | To be mentioned                                                 |  |
| Manufacturer's Model Number                                     |      | To be mentioned                                                 |  |
| Windows                                                         | Nos. | Minimum 24                                                      |  |
| Built in buzzer and buttons for accept, mute, test, reset, etc. |      | Yes                                                             |  |
| <b>Control Switch</b>                                           |      |                                                                 |  |
| Manufacturer's Name                                             |      | To be mentioned                                                 |  |
| Country of Origin                                               |      | To be mentioned                                                 |  |

|                                                                                  |  |                                            |  |
|----------------------------------------------------------------------------------|--|--------------------------------------------|--|
| Manufacturer's Model Number                                                      |  | To be mentioned                            |  |
| Separate Discrepancy switch for CB on/off and Local Remote (L/R) selector switch |  | Yes                                        |  |
| 1 (One) nos. breaker Emergency trip                                              |  | To be provided                             |  |
| Mounting of Relays and Meters                                                    |  | All Relay and Meter shall be flush mounted |  |

| <b>33/11 kV POWER TRANSFORMER FEEDER</b>         |             |                                                                                                                                          |  |
|--------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>Description</b>                               | <b>Unit</b> | <b>BREB's Requirement</b>                                                                                                                |  |
| <b>PROTECTION (DIFFERENTIAL &amp; REF RELAY)</b> |             |                                                                                                                                          |  |
| Manufacturer's Name & Country                    | -           | Siemens (Germany)/ GE (USA/UK) ABB (Sweden/Switzerland/Finland)                                                                          |  |
| Model Name                                       | -           | To be mentioned                                                                                                                          |  |
| Type of relay                                    | -           | Numerical Programmable with built-in display                                                                                             |  |
| Main protection function                         |             | Transformer differential protection with built in low impedance REF protection feature                                                   |  |
| Differential characteristics                     |             | Restrained biased characteristics with stabilization during magnetizing inrush and CT saturation                                         |  |
| CT ratio matching and vector group compensation  |             | Internally done, software based                                                                                                          |  |
| Application                                      |             | For 2 winding Transformers                                                                                                               |  |
| Tripping time                                    |             | Instantaneous                                                                                                                            |  |
| Restricted Earth Fault                           |             | Low impedance type                                                                                                                       |  |
| Back up protection function                      |             | Instantaneous & time dependent, directional & non-directional, over current & earth fault, Over excitation & Thermal Overload Protection |  |
| Display options                                  |             | There must be provision of displaying restraining, differential & each phase current with angle (for both winding) on the HMI            |  |
| Language                                         |             | English                                                                                                                                  |  |
| Relay Auxiliary Voltage                          | V           | Minimum 88-250V DC and Minimum 115-250V AC                                                                                               |  |
| Nominal Current                                  | A           | Operable in 1A & 5A (User Settable)                                                                                                      |  |
| Harmonics blocking                               |             | 2 <sup>nd</sup> and 5 <sup>th</sup> harmonics                                                                                            |  |
| HMI                                              |             | Front mounted, should be suitable to access all functions, settings and stored records without external computer                         |  |

|                                                                          |     |                                                                                                                                                                                                                                                                                                |    |
|--------------------------------------------------------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Software Requirement                                                     |     | a) Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>b) Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license with probe/cable. | c) |
| Event Record & Oscillographic Disturbance Records                        |     | Event recorder should keep at least 20 Nos previous records and disturbance recorder should handle all analogue channels and binary channels                                                                                                                                                   |    |
| Standard Protocol                                                        | -   | IEC 61850                                                                                                                                                                                                                                                                                      |    |
| Minimum No of LEDs                                                       | Nos | 10 (Programmable)                                                                                                                                                                                                                                                                              |    |
| Test Terminal Block (TTB) for OC & EF Relay (incl. male and female part) |     | Yes                                                                                                                                                                                                                                                                                            |    |

|                                                                                                                                |      |                                    |  |
|--------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------|--|
| Standard                                                                                                                       |      | IEC 60255                          |  |
| Bay control unit should have available                                                                                         | -    | Yes                                |  |
| Minimum No of Binary Input                                                                                                     | Nos. | 13                                 |  |
| Minimum No of Binary Output                                                                                                    | Nos. | 13                                 |  |
| IEC 61850 communication Protocol Supported                                                                                     |      | To be provided                     |  |
| U, I, P, Q, S, f, PF monitoring                                                                                                |      | Yes                                |  |
| No of Communication Ports (rear)<br>i) Optical<br>ii) Electrical<br>(Minimum 1 Optical Ports with redundancy must be provided) |      | To be mentioned<br>To be mentioned |  |



| <b>PROTECTION (OVER CURRENT &amp; EARTH FAULT RELAY)</b> |                |                                                                                                                                                                                                                                                                                                |    |
|----------------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Manufacturer's Name & Country                            | -              | Siemens (Germany)/ GE (USA/UK) ABB (Sweden/Switzerland/Finland)                                                                                                                                                                                                                                |    |
| Type of relay                                            | -              | Numerical Programmable with built-in display                                                                                                                                                                                                                                                   |    |
| Range setting                                            |                |                                                                                                                                                                                                                                                                                                |    |
| a) Phase element of current                              | % of CT rating | 5% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| b) Earth fault element of current                        |                | 1% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| c) Time Multiplier Setting (TMS)                         |                | 0.025 to at least 1.5 (Step Size 0.005)                                                                                                                                                                                                                                                        |    |
| Ranges of timing at DMT                                  | Sec            | 0-100 (with 1ms interval)                                                                                                                                                                                                                                                                      |    |
| Language                                                 |                | English                                                                                                                                                                                                                                                                                        |    |
| Relay Auxiliary Voltage                                  | V              | Minimum 88-250V DC and Minimum 115-250V AC                                                                                                                                                                                                                                                     |    |
| Nominal Current                                          | A              | Operable in 1A & 5A (User Settable)                                                                                                                                                                                                                                                            |    |
| Minimum No of LEDs                                       | Nos            | 10 (Programmable)                                                                                                                                                                                                                                                                              |    |
| HMI                                                      |                | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                                               |    |
| Software Requirement                                     |                | a) Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>b) Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license with probe/cable. | c) |
| Event Record & Oscillographic Disturbance Records        |                | Event recorder should keep at least 20 Nos previous records and disturbance recorder should handle all analogue channels and binary channels                                                                                                                                                   |    |
| Standard Protocol                                        | -              | IEC 61850                                                                                                                                                                                                                                                                                      |    |
| Protection Feature                                       |                | Non-directional & Directional (if required)                                                                                                                                                                                                                                                    |    |
| Test Terminal Block (TTB) for                            |                | Yes                                                                                                                                                                                                                                                                                            |    |

|                                            |      |                |  |
|--------------------------------------------|------|----------------|--|
| OC & EF Relay (incl. male and female part) |      |                |  |
| Standard                                   |      | IEC 60255      |  |
| Bay control unit should have available     | -    | Yes            |  |
| Minimum No of Binary Input                 | Nos. | 32             |  |
| Minimum No of Binary Output                | Nos. | 18             |  |
| IEC 61850 communication Protocol Supported |      | To be provided |  |

|                                                                                                                                                             |      |                                               |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------------|--|
| Sync Check function                                                                                                                                         |      | To be mentioned                               |  |
| U, I, P, Q, S, f, PF monitoring                                                                                                                             |      | Yes                                           |  |
| No of Communication Ports (rear) (Minimum 1 Optical Ports with redundancy must be provided)                                                                 |      | To be mentioned                               |  |
| <b>Trip Relay (Separate Relay for each Numerical Relay)</b>                                                                                                 |      |                                               |  |
| Manufacturer's Name                                                                                                                                         |      | To be mentioned                               |  |
| Place of Manufacture                                                                                                                                        |      | UK/USA/EU/Japan/Canada/Australia/ Switzerland |  |
| Manufacturer's Model Number                                                                                                                                 |      | To be mentioned                               |  |
| Type of Relay                                                                                                                                               |      | To be mentioned                               |  |
| Maximum Operating Time                                                                                                                                      | ms   | 10                                            |  |
| Minimum No of Contact (NO + NC)                                                                                                                             | Nos  | 6 + 6                                         |  |
| Hand & Electrical reset mechanism                                                                                                                           |      | Yes                                           |  |
| Rated voltage                                                                                                                                               | V DC | 88-125V                                       |  |
| <b>Trip Circuit Supervision (TCS) Relay (Separate Relay for each trip coil)</b>                                                                             |      |                                               |  |
| Manufacturer's Name                                                                                                                                         |      | Siemens/ABB/Alstom/GE                         |  |
| Manufacturer's Model Number                                                                                                                                 |      | To be mentioned                               |  |
| Type of Relay                                                                                                                                               |      | To be mentioned                               |  |
| Design                                                                                                                                                      |      | Modular type                                  |  |
| <b>Separate Auxiliary Flag Relays for Transformer self-protection (i.e., OTA, OTT, WTA, WTT, MTBA, MTBT, PRDT, OLTCBA, OLTCBT, MTMOLGA, OLTCMOLGA etc.)</b> |      |                                               |  |

|                                                                              |      |                                                                                                                      |  |
|------------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------|--|
| Manufacturer's Name                                                          |      | To be mentioned                                                                                                      |  |
| Place of Manufacture                                                         |      | UK/USA/EU/Japan/Canada/Australia/Switzerland                                                                         |  |
| Manufacturer's Model Number                                                  |      | To be mentioned                                                                                                      |  |
| Type of Relay                                                                |      | To be mentioned                                                                                                      |  |
| Reset type                                                                   |      | Hand + Electrical                                                                                                    |  |
| <b>Ampere Meters</b>                                                         |      |                                                                                                                      |  |
| Manufacturer's Name                                                          |      | Siemens/ABB/GE/CE WE/Schlumberger/AEG/Alstom                                                                         |  |
| Manufacturer's Model Number                                                  |      | To be mentioned                                                                                                      |  |
| Type of meter                                                                |      | Digital                                                                                                              |  |
| Class of accuracy                                                            |      | 0.5                                                                                                                  |  |
| Separate meter for each phase                                                |      | Yes                                                                                                                  |  |
| Instantaneous rated current                                                  |      | To be mentioned                                                                                                      |  |
| ISF                                                                          |      | Minimum 10                                                                                                           |  |
| <b>Volt Meters with Selector Switch</b>                                      |      |                                                                                                                      |  |
| Manufacturer's Name                                                          |      | Siemens/ABB/GE/CE WE/Schlumberger/AEG/Alstom                                                                         |  |
| Manufacturer's Model Number                                                  |      | To be mentioned                                                                                                      |  |
| Type of meter                                                                |      | Digital                                                                                                              |  |
| Class of accuracy                                                            |      | 0.5                                                                                                                  |  |
| <b>Multifunction Meter (kW, kWh, kVARh, Voltage, Current, PF, Frequency)</b> |      |                                                                                                                      |  |
| Manufacturer's name & Country                                                |      | Siemens (Germany/Switzerland)/Alstom (UK)/ABB (Finland/Switzerland)/AEG (Germany)/Schlumberger (USA)/CEWE (UK/Italy) |  |
| Model Number                                                                 | -    | To be mentioned                                                                                                      |  |
| Number of Meters                                                             | Nos. | Multifunction meter containing (3 nos Ammeter, 3 nos voltmeter, 1 nos kW meter, 1 nos kVAR meter,                    |  |
|                                                                              |      | 1 nos PF meter, 1 nos frequency meter)                                                                               |  |

|                                                           |          |                                                                                                                                                                                                                                                                                               |  |
|-----------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Type of meter                                             | -        | Digital                                                                                                                                                                                                                                                                                       |  |
| Class of accuracy                                         | -        | 0.2                                                                                                                                                                                                                                                                                           |  |
| Export & Import Metering                                  |          | Export & Import                                                                                                                                                                                                                                                                               |  |
| <b>Multi tariff programmable Energy meter (kWh Meter)</b> |          |                                                                                                                                                                                                                                                                                               |  |
| Manufacturer's name & Country                             |          | Siemens (Germany/Switzerland)/Alstom (UK)/ABB (Sweden)/AEG (Germany)/ Schlumberger (USA)/Landis Gyr (Switzerland/Greece)/CEWE (UK/Italy)                                                                                                                                                      |  |
| Model Number                                              | -        | To be mentioned                                                                                                                                                                                                                                                                               |  |
| Number of KWh Meters                                      | Nos.     | 1                                                                                                                                                                                                                                                                                             |  |
| Class of accuracy                                         | -        | 0.2S                                                                                                                                                                                                                                                                                          |  |
| Installation                                              |          | Indoor installation                                                                                                                                                                                                                                                                           |  |
| Number of element                                         |          | 3 (Three)                                                                                                                                                                                                                                                                                     |  |
| Nominal Voltage                                           | V        | 110                                                                                                                                                                                                                                                                                           |  |
| Construction/connection                                   |          | 3-Phase 4-wire solidly grounded neutral                                                                                                                                                                                                                                                       |  |
| Export & Import Metering                                  |          | Export & Import                                                                                                                                                                                                                                                                               |  |
| Nominal Rated Current                                     | A        | Both 1A and 5A                                                                                                                                                                                                                                                                                |  |
| Type of the meter                                         |          | Numerical Programmable, Multifunction with accuracy Class 0.2S, Load profile, instrumentation profile for minimum 1 yr with an interval of 30 min, software for protection and optical probe for data download as per IEC with provision of communication port automatic meter reading (AMR). |  |
| Starting Current                                          | mA       | 0.1% of Nominal Current                                                                                                                                                                                                                                                                       |  |
| Losses at Nominal Load                                    |          |                                                                                                                                                                                                                                                                                               |  |
| a) Current Circuit                                        | W, VA    | To be mentioned                                                                                                                                                                                                                                                                               |  |
| b) Voltage Circuit                                        | W, VA    | To be mentioned                                                                                                                                                                                                                                                                               |  |
| Meter Constant                                            | Imp./kWh | To be mentioned                                                                                                                                                                                                                                                                               |  |
| Integration Period                                        |          | 30 (Thirty) Minutes                                                                                                                                                                                                                                                                           |  |
| Battery Service life and shelf Life (minimum)             | Years    | 10 (ten) & 15 (fifteen)                                                                                                                                                                                                                                                                       |  |
| Meter Service Life (Min)                                  | Years    | 15 (fifteen)                                                                                                                                                                                                                                                                                  |  |

|                                                                     |    |                                                         |  |
|---------------------------------------------------------------------|----|---------------------------------------------------------|--|
| Meter sealing condition                                             |    | Hermetically or Ultrasonic welded (means break to open) |  |
| Memory Storage                                                      | MB |                                                         |  |
| i) No of Power Interruption with Date & Time                        |    | Yes                                                     |  |
| ii) Latest Power Failure- Time & Date                               |    | Yes                                                     |  |
| iii) Event logs                                                     |    | Yes                                                     |  |
| iv) Cumulative kWh, kVARh (Q1 + Q4) Reading for previous two months |    | Yes                                                     |  |
| v) Load profile with 30 min interval at least 01 (One) year for:    |    |                                                         |  |
| a) kWh, kVARh (Q1+Q4)                                               |    | Yes                                                     |  |
| b) Phase Voltage or Vh                                              |    | Yes                                                     |  |
| c) Phase Amps or Ah                                                 |    | Yes                                                     |  |

|                                                                 |      |                                                        |  |
|-----------------------------------------------------------------|------|--------------------------------------------------------|--|
| Communication Facilities                                        |      | RS 232, RS 485, RJ45, GSM-GPRS and Modbus or IEC 61850 |  |
| GSM-GPRS Modem                                                  |      | Plug and Play 4G Communication Module                  |  |
| Optical Probe & TTB(incl. male & female part)                   |      | To be provided                                         |  |
| <b>Annunciator</b>                                              |      |                                                        |  |
| Manufacturer's Name                                             |      | To be mentioned                                        |  |
| Country of Origin                                               |      | To be mentioned                                        |  |
| Manufacturer's Model Number                                     |      | To be mentioned                                        |  |
| Windows                                                         | Nos. | Minimum 32                                             |  |
| Built in buzzer and buttons for accept, mute, test, reset, etc. |      | Yes                                                    |  |
| <b>Control Switch</b>                                           |      |                                                        |  |
| Manufacturer's Name                                             |      | To be mentioned                                        |  |
| Country of Origin                                               |      | To be mentioned                                        |  |
| Manufacturer's Model Number                                     |      | To be mentioned                                        |  |

|                                                                                  |  |                                            |  |
|----------------------------------------------------------------------------------|--|--------------------------------------------|--|
| Separate Discrepancy switch for CB on/off and Local Remote (L/R) selector switch |  | Yes                                        |  |
| 1 (One) nos. breaker Emergency trip                                              |  | To be provided                             |  |
| Mounting of Relays and Meters                                                    |  | All Relay and Meter shall be flush mounted |  |

## 11 KV Indoor Switchgear

### General

The 11 kV switchgear shall consist of a single bus-bar, metal clad, indoor type, floor mounted, single tier integrated unit, incorporating enclosures for the circuit breaker units, bus-bars, current transformers and auxiliary wiring.

Each 11 kV CB shall be provided with a combined relay & control panel forming an integral part of the circuit breaker equipment.

The panels shall be equipped with the necessary protection control devices, master trip relay, TCS relay, indicating instruments, Annunciator and alarming devices, MCBs, etc.

The switchgear shall be of robust construction designed for maximum reliability of service in the tropical climate specified.

Cable boxes shall be supplied complete with glands and terminal lugs.

### Clearances

Maximum insulator lengths and clearances in air shall be not less than those specified for 11 kV switchgear having 75 KVp Basic Impulse Level.

### Current Ratings

All parts of the switchgear, including current transformers, shall be capable of withstanding, without thermal or mechanical damage, the instantaneous peak and the three (03) second short time current corresponding to the rated making and breaking capacity of the circuit breakers.

All normal current specified are the minimum continuous values required under the service conditions appertaining to Bangladesh.

### Circuit Breaker making and Breaking capacities

Each circuit breaker shall be capable of making and breaking short circuit faults in accordance with the requirements of IEC 56 - Circuit Breaker, at 3 phase symmetrical circuit ratings at 11 kV service voltages as stated in the schedules.

## **Circuit Breakers**

### **Type**

The 11 kV circuit breakers shall be vacuum type in accordance with IEC 56 as appropriate. All types shall incorporate horizontal isolation facilities and be mounted on horizontal draw-out type.

### **Interchangeability of Circuit Breakers**

Circuit breaker of the same type and current rating shall be interchangeable, both electrically and mechanically, but it must be impossible to interchange equipment of different current ratings.

### **Circuit Breaker Operation Mechanism**

Circuit breaker closing mechanisms shall be 230-volt ac motor wound preferably spring-operated type such that the closing speed is independent of the operator.

11kV switchgear tripping shall be affected by means of 02 nos. of 110 volt dc shunt trip coil. All controls shall be suitable for 80% to 110% for closing & 70% to 110% for tripping of 110V D.C. The A.C. supply shall be available 415/230 Volt, 50 Hz.

The circuit breakers and their components shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current of the system without any damage or deterioration of material.

The circuit breakers shall have motor wound spring charged trip free mechanism with anti-pumping feature, and shunt trip. In addition, facility for manual charging of spring shall be provided.

Each equipment shall be provided with a visual, mechanized, indicating device, which shall be positively driven in both directions to show whether the circuit breaker is "Open" or "Closed". It shall be operative when the circuit breaker is in the "Service" and "Test" locations. Lamp indication in place of a mechanical indicator will not be accepted. Operation counters shall be provided on each mechanism.

Means shall be provided for coupling the secondary circuits on the fixed portion to those on the movable portion when the circuit breaker is isolated in order to permit closing, tripping and interlock circuits to be checked for operation test purposes.

Means shall be provided for local manual mechanical tripping of circuit breakers, preferably by push buttons, shrouded to prevent inadvertent operation.

Locking facilities shall be provided so that with the circuit breaker in any location it can be prevented from being closed when it is open and from being mechanically tripped when it is closed. This requirement shall be met by the fitting of a single padlock and shall not entail the fitting of any loose components prior to the insertion of the padlock.

It shall not be possible, without the use of tools, to gain access to the tripping toggle or any part of the mechanism which would permit defeat of the locking of the mechanical tripping feature.

It shall not be possible to render the electrical tripping feature inoperative by any mechanical locking device.

Each vacuum Circuit breaker shall comprise of three identical poles linked together electrically and mechanically for synchronous operation. The vacuum interrupter, consisting of fixed contact and moving contact, shall be interchangeable among the same type interrupter. Short circuit capacity of vacuum bottle should be 31.5 KA and design life should be 100 nos. Operation at rated short circuit level. The operation of the interrupter will be 30000 nos. at rated current. The country of origin and manufacturing place of vacuum interrupter shall be UK/EU/Switzerland/USA/ Japan/Canada/Australia.

The mechanism shall have anti-pumping circuitry and will be trip free electrically and mechanically. The anti-pumping arrangement shall be initiated through normally "NO" type, direct auxiliary contact of circuit breaker and shall be of self hold type. Plug-in type relay/Contactor for Anti-pumping Relay will not be acceptable. Spring operated mechanism will be complete with opening spring, closing spring, limit switch and all necessary accessories to make the mechanism a complete operating unit. Spring charging LS shall have sufficient no. of spare contact.

Vacuum bottle with its insulator encasing chamber shall be hermetically sealed. Free passage of air in the chamber with or without provision of circulation of hot air is not accepted. Tripping/Closing Coil burden of Equipment should not be more than 200 watts at 110 V D.C. The value will not be relaxed, specially for tripping coil.

Breaker shall be provided with 9 NO & 9 NC spare auxiliary contacts in addition to the auxiliary contacts required for Breaker's own operational requirements. These auxiliary contacts shall preferably be convertible type. These contacts shall have continuous current rating of at least 10A. The breaking capacity shall be adequate for the circuits controlled, or at least 12A at 110 V DC with a circuit time constant of minimum 20 ms. All these contacts shall be wired up to terminal block in the control cubicle separately. Auxiliary contacts which are to be installed on the frame of Circuit Breaker shall be suitably protected against accidental arcing from main circuit. Insulating materials of contacts shall be ceramics or other non-tracking materials.

Maximum temperature attained by any part of the Equipment at specified rating should not exceed the permissible limit as stipulate in the relevant standards. Equipment shall be designed taking 50°C as maximum ambient temperature.

#### Control Panel and Protective Relays

Protective relays with test terminal block (TTB) must be provided with the breaker. The relays must be numerical relays. The manufacturer name and country of the protective relays shall be Siemens (Germany)/ ABB (Sweden/Switzerland/Finland)/GE (USA/UK) for over current, earth fault protection with directional feature in 11kV incomer feeders. All the relays should be 61850 protocol type for automation network of the 33/11.55 kV Substation. The no of relay binary input and output contact shall depend upon whether the 33/11.55 kV substation is GIS or AIS type.

There must be master trip relay with each protective relay. For each tripping coil there must have trip circuit supervision relay. An annunciator shall be provided for alarm and indication purpose.

There must have 1 nos energy meter, 1 nos multifunction meter, 3 nos. Ammeter, 1 nos. voltmeter with selector switch, Test terminal block, ON/OFF/Auto Trip/Spring Charge etc. indication lamps of different colors. All indication meters will be Digital.

All relay and meter in the control and meter panel must be flush mounted type. The cable size for CT secondary circuit will be 4 mm<sup>2</sup> and cable size 2.5 mm<sup>2</sup> will be used for PT circuit, control circuit, indication circuit and others.

Thermostat controlled heaters shall be provided to prevent condensation both control relay panel and busbar compartment within cubicle. Cubicle illumination Lamp with switch and a 230 V, 15A, 3 pin sockets with a Control Switch shall be provided. All controls, alarms, indications and interlocking devices furnished with breaker shall be wired up to the terminal Block in the common control cubicle. Not more than two wires shall be connected to one terminal. All wires shall be identified at both ends with ferrule marking in accordance with approved wiring diagram. Terminal blocks shall have compression type multi-way terminals with bonding screws and washers. At least 15% spare terminal shall be provided.

#### Circuit Breaker Isolating Features

Irrespective of the operating type of unit the following shall apply.

Each circuit breaker shall be connected to the busbars and feeder circuit through plug and socket type isolating devices. The devices shall be of the "Off Load Type" but shall be suitable for operation whilst the busbars and/or feeder circuits are alive.

Isolating devices shall be interlocked with their respective circuit breakers to prevent their making or breaking load, but arrangements whereby attempted isolation of a closed-circuit breaker trips the circuit breaker are not permitted.

The main circuit isolating devices and also all secondary circuit isolating contacts shall be of the self-aligning type, mounted in accessible positions to permit maintenance.

The number of auxiliary circuit isolating switches shall be sufficient to meet the facilities.

#### Interlocks

All mechanical interlocks shall be of the preventive type and shall be arranged to prevent mal operation as close as possible to the point at which mechanical force is applied, in order to prevent defeat of the interlocks by distortion of linkages Electrical interlocks shall also function so as to prevent the closing of the circuit breaker.

Clearly labelled mechanical interlocks shall be provided which are designed to prevent:

- a) A closed-circuit breaker from being withdrawn or inserted into the isolating contacts.



- b) Tripping by attempted isolation.
- c) The closing of a circuit breaker except when correctly located in Service or Test positions.
- d) A circuit breaker from being plugged into the isolation contacts if the tank is not in position
- e) A circuit breaker being closed in the service position when the secondary circuits between the fixed and moving portions are not completed.

In addition electrical interlocks may be utilized to ensure safe operation of the plant; i.e. on 11 kV transformer incoming circuits the circuit earth position shall not be operative unless the 33 kV circuit is de-energized and isolated etc.

#### Safety Shutter Devices

A set metal shutters shall be provided to cover each 3-phase group of stationary isolating contacts.

The shutters shall open automatically by a positive drive initiated by the movement of the circuit breaker. The closing operation shall also be automatic by positive drive

When padlocked closed, the shutters shall completely shroud the stationary contacts, and it shall not be possible to force the shutters or part of the shutters to gain access to the stationary contacts.

To facilitate testing, means other than locking shall be provided for securing the shutters in the open position. However, such means shall be automatically cancelled when the automatic operation of the shutters restored upon reconnection of the circuit breaker.

Bus-bar shutters shall be painted signal red, colour 537 in BS 381 C, and shall be clearly and indelibly labelled "BUSBARS" in large white letter in English. The contractor may offer works which comply with different standards or codes only if, when requested by the Engineer Circuit shutters shall be painted yellow, colour 355 in BS 381 C, but shall not be lettered, except that on incoming feeders the circuit shutters shall be clearly and indelibly labelled "DANGER LIVE CABLES" in large red letters.

Voltage transformer spout shutters shall be painted yellow, colour 355 in BS 381 C. Durable phase colour identification shall be provided in a prominent position. Provision or access shall be made for lubricating the mechanical linkages.

All shutters shall be effectively earthed. Shutters shall not operate towards the fixed isolating contacts.

#### Bus-bars and Connections

The equipment shall be of single busbar type and material will be copper. Busbars and connection shall comply with applicable clauses of IEC 298 and shall be fully insulated.

The equipment shall be of single busbar type. The busbar assemblies shall be of a type which shall not rely only on air for insulation purpose.

Any earthed screen applied to the exterior of the insulation shall be securely earthed in each busbar compartments.

The insulation of the busbars and their connections shall be capable of withstanding, without damage, the thermal and mechanical effect of a through fault current equivalent to the short-time rating of the switchgear. Access to busbars and the connections directly thereto shall be gained only by the removal of covers secured by bolts or screws. Such covers shall be marked clearly and indelibly "BUSBARS"

Busbars shall extendible at both ends; such extension shall entail the minimum possible disturbance to the busbar chambers. Compound filled busbar chambers are not acceptable.

The isolating equipment/Insulator from busbar to panel body must be maintained proper design and creepage as per mentioned in IEC standard.

#### Earthing of Metal Parts of Switchgear

All metal parts, other than those forming part of an electrical circuit, shall be connected to a hard-drawn, high conductivity, copper earth conductor on each unit, of adequate sectional area.

The frame of draw-out circuit breakers shall be connected to the earth bar through a substantial plug type contact and the plug shall be long enough to allow the busbar and feeder shutters to close before breaking contact.

Interlocking (both mechanical & electrical) must be provided to avoid accidental earthing circuit breaker in "service position".

## Earthing of Insulations

Earthing of the switchgear and ancillary panels and auxiliary equipment shall be carried out in accordance with IEEE Standard 80 & 142 where applicable.

## Insulators

Porcelain insulators shall be best quality electrical porcelain. The clamping surfaces of all porcelain insulators shall be accurately ground and shall be free of glaze.

Insulators of moulded or resin bonded material shall have a durable, non-hygroscopic surface finish having a high anti-tracking index.

## Auxiliary switch

Each circuit breaker shall be provided with adequate no. Auxiliary switches to interrupt the supply to the closing mechanism and to complete the trip circuit, when the circuit breaker is in the "Closed" position and to cover all the necessary indication, interlocking and control facilities with spare contacts.

Each circuit breaker shall be provided with clean auxiliary contacts for the purpose of providing remote switch and alarm indication at the remote grid supervisory centre. In addition each circuit breaker shall be provided with the necessary 50 volt dc interposing relays required to achieve remote control of the circuit breaker via a future remote grid supervisory system. All auxiliary switches shall be wired down whether in use or not to the appropriate 148labelled148ng kiosk.

## Special Tools

One complete set of all special tools that are necessary for the overhauling maintenance and adjustment of the whole equipment shall be provided with each switchboard. The tools provided shall be in a new condition and shall not be used for the erection of the equipment on Site.

## Indoor Breaker Specification

The 11 kV switchgear unit indoor vacuum CB will be draw out type along with CT, 11 kV bus, 11 kV PT (3×single phase unit–draw out type). The C.B shall have spring operating mechanism suitable for charging by motor (A.C 230 V, 1 phase) with provision of hand charging. Sufficient auxiliary contacts shall be provided for position indication, interlocks and other purposes. Two sets of independently operative trip coils shall be there. Anti pumping features should be introduced with the Breaker. All the current carrying parts should be copper.

### Technical Particulars of 11 kV Circuit Breakers:

|                                        |                                                                  |
|----------------------------------------|------------------------------------------------------------------|
| Phase                                  | 3-phase                                                          |
| Service Voltage/Maximum system Voltage | 11kV/12 kV                                                       |
| Continuous rating current of Bus-bar   | 2000 Amps.                                                       |
| Continuous rating current              | 1250A (Incomer Feeder), 2000A (Bus Section), 630A (Line Feeder). |
| Basic Impulse Level (BIL)              | 75 kV,                                                           |
| Power frequency withstand voltage      | 28 kV.                                                           |

Bus Shall be 3 phase, 50Hz, 2000A, air insulated capable of withstanding 31.5 kA for 3 sec.

### Current Transformers (CTs)

The current transformer rated current ratio shall match the connected load circuit and secondary circuit requirements. Current transformers shall be capable of withstanding without damage the full load, peak and rated short time currents of their associated equipment.

Where space within a current transformer chamber permits dedicated current transformers shall be used for protection, instrumentation and metering.

Current transformers used for energizing indicating instruments and metering shall be of Class 0.2S accuracy and 5P20 for protection purpose in accordance with IEC 185.

Current transformers for protective and protective/indication purposes shall be designed to suit the particular requirements of the associated protection, which in general shall be in accordance with the recommendations given in BS 3938 or approved equivalent.

Class 5p current transformers shall be used for inverse time over-current and/or earth fault protection. The rated accuracy limit current shall be equivalent to the maximum symmetrical three phase fault current or earth fault current of the protected circuit or equivalent to the switchgear breaking capacity. The current transformers shall be capable of meeting the 5p error classification at rated accuracy limit current over the full range of relay settings.

Current transformers used for indication/metering purposes shall be designed to saturate at a value of primary current sufficiently low to protect the secondary circuit from damage at all possible values of primary fault current up to the associated primary short time thermal rating.

Current transformers for combined purposes (e.g. protection relays and indicating meters) shall have a dual Class 5p/Class 1 performance, and the secondary circuit shall have an approved means (saturating reactor or saturating interposing C.T.) of protecting the meters and reducing their burden under system fault conditions.

The rated volt-amp output of each current transformer shall not be less than 110% of the connected burden as installed in service, the burden of cable connections being taken into account.

The secondary windings of each set of current transformers shall be earthed at one point only via an accessible bolted disconnecting link, preferably located within the relay cubicle.

Where double-ratio secondary windings are specified provided a label shall be provided at the secondary terminals of the current transformer indicating clearly the connections required for either tap. The connections and the ratio in use shall be indicated on all connection diagrams.

Design magnetization curves and d.c resistance values shall be submitted before manufacture for each current transformer used for protective purposes and shall be subsequently verified by works routine tests and also by site commissioning tests.

Where current transformers have to operate or be mounted on apparatus provided under other contracts, the Contractor shall be responsible for ensuring design and installation compatibility with other Contractors and for keeping the Engineer informed.

Metal clad switchgear current transformers shall be located on the non-bus-bar side of the circuit breaker except where current transformers are provided on both sides of the circuit breaker for protection zone overlap. The primary conductors shall be accessible for primary current injection treating on site.

### Voltage Transformers (VTs)

Voltage transformers shall comply with the requirements of IEC 186 with amendments and supplements and shall be of:-

- Class 3P accuracy for protection/indicating instruments
- Class 0.2 accuracy for tariff metering or acceptance efficiency testing.

The VA output shall be 50% in excess of the design requirements except for tariff metering voltage transformers which shall be at least 10% in excess of the design requirements.

For tariff metering voltage transformers the Contractor shall check the total installed secondary burden and if necessary shall install dummy burdens to achieve the calibrated accuracy.

Voltage transformer secondary circuit shall be earthed at one point only and metal cases shall be separately earthed. The transformers core, where accessible, shall also be separately earthed.

All voltage transformers in the system at a given voltage level shall be earthed in the same manner.

Where it is required to earth the primary neutral of a metal clad three- phase voltage transformer, the neutral earthing connection shall be insulated and brought out separately from the tan earthing connection. Means shall be provided to maintain the tank earthing connection while the voltage transformer is being withdrawn.

Where three single-phase voltage transformers are supplied for protection purposes, star connected secondary windings shall have the star point formed by insulated connections and shall be earthed at a common point.

Where necessary for earth fault protection, voltage transformers shall be of five- limbed core construction. Where possible primary windings shall be connected through fuses with current limiting features.

Secondary MCB's shall be provided as close as possible to each voltage transformer and able to show their function and phase colour. The secondary circuits shall be monitored individually to detect and alarm individual fuse failure or MCB trip and to block protection operation if required.

Voltage transformers shall be designed that saturation of their cores does not occur when 1.732 times normal voltage is applied to each winding. Magnetization curves shall be submitted for approval for each type of voltage transformer.

The standard secondary voltage between phases shall be 110 volts unless special circumstances dictate otherwise and are approved by the Engineer.

Secondary circuits from different voltage transformers, or separate windings of the same transformer, shall not be connected in parallel.

Voltage transformers shall be connected on the non-busbar side of circuit breakers unless otherwise approved by the Engineer.

### **Test Certificate of 11 kV Indoor Type Circuit Breaker**

#### **A. Type Tests:**

##### **For Breaker:**

- a) short time withstand and peak withstand current test
- b) Lightning impulse voltage withstand test
- c) Temperature rise Test
- d) Mechanical Endurance Test
- e) Measurement of the resistance of the main circuit
- f) Short circuit current making and breaking tests

##### **For CT:**

- a) Lightning impulse voltage (Chopped impulse and full impulse);
- b) Power frequency wet withstand voltage;
- c) Temperature rise;
- d) short circuit withstand capability test;
- e) Current error and phase displacement
- f) Switching impulse.

##### **For PT:**

- a) Lightning impulse voltage test;
- b) High voltage power frequency wet withstand voltage;
- c) Temperature rise test;
- d) short circuit withstand capability test;
- e) Switching impulse;
- f) Determinations of error;

##### **For Control Panel & Relays:**

Required tests as per relevant IEC 62271-111 Standard.

**Routine test****For Breaker:**

- g) Dielectric test on main, auxiliary and control circuit
- h) Measurement of the resistance of the main circuit
- i) Tightness test
- j) Mechanical operation tests
- k) Design and visual checks

**For CT:**

- a) Verification of terminal marking and polarity;
- b) Power frequency dry withstand test on both windings;
- c) Power frequency dry withstand test between sections;
- d) Over voltage inter-turn test;
- e) Turn ratio;
- f) Instrument security factor test;
- g) Determinations of error;
- h) Secondary winding resistance and Accuracy test;
- i) Current error and phase displacement;
- j) Knee point voltage and magnetizing current test;
- k) Insulation Resistance Test;

**For PT:**

- a) Verification of terminal marking and polarity;
- b) Power frequency dry withstand tests on both winding;
- c) Power frequency withstand tests between sections;
- d) Determination of limits of voltage errors and phase displacement;
- e) Partial discharge measurement;
- f) Insulating Resistance measurement;

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE FOR 11kV SWITCHGEAR AND CONTROL EQUIPMENT**

| Description                                                                 | Unit       | BREB's Requirement                           |  |
|-----------------------------------------------------------------------------|------------|----------------------------------------------|--|
| <b>INCOMING FEEDER SWITCHGEAR UNITS</b>                                     |            |                                              |  |
| Manufacturer's Name & Address                                               |            | To be mentioned                              |  |
| Applied standard                                                            |            | To be mentioned                              |  |
| Rated nominal voltage                                                       | kV         | 11                                           |  |
| Rated Voltage                                                               | kV         | 12                                           |  |
| Rated current for bus                                                       | A          | 2000                                         |  |
| Rated short time current                                                    | kA         | 31.5                                         |  |
| Short time current rated duration                                           | Sec.       | 03                                           |  |
| <b>Circuit Breaker:</b>                                                     |            |                                              |  |
| Type                                                                        |            | VCB                                          |  |
| Vacuum Interrupter – Country of Origin and Manufacture (Shall be the same)  |            | UK/USA/EU/Japan/Canada/Australia/Switzerland |  |
| Rated Voltage                                                               | kV         | 12                                           |  |
| Rated Current                                                               | A          | 1250 (for 10 MVA)<br>2000 (for 20 MVA)       |  |
| Rated short Ckt. Breaking current, 3 Sec.                                   | kA         | 31.5                                         |  |
| Rated short Ckt. Making current                                             | kA         | 80                                           |  |
| First pole to clear factor                                                  |            | 1.5                                          |  |
| Rated breaking time                                                         | Cycle      | < 3                                          |  |
| Opening time                                                                | ms         | ≤ 60                                         |  |
| Closing time                                                                | ms         | ≤ 70                                         |  |
| Contact resistance                                                          | μΩ         | < 40                                         |  |
| No of Operation<br>a) At Rated short circuit current<br>b) At rated current | Nos<br>Nos | 100<br>30000                                 |  |
| Rated operating sequence                                                    |            | 0-0.3 sec-CO-3 min-CO                        |  |
| Control voltage                                                             | V          | DC 110                                       |  |
| Motor voltage for spring charge                                             | V          | AC 180-240                                   |  |
| No. of Trip coil                                                            | No.        | 02                                           |  |
| <b>Current Transformer:</b>                                                 |            |                                              |  |
| Rated Voltage                                                               | kV         | 12                                           |  |
| Accuracy class, Metering                                                    |            | 0.2S                                         |  |
| Accuracy class, Metering                                                    |            | 0.2S                                         |  |
| Accuracy class, Protection                                                  |            | 5P20                                         |  |
| Accuracy class, Protection                                                  |            | 5P20                                         |  |
| Rated current ratio                                                         | A          | 2000-1000:5-5-5-5                            |  |
| Factor of security                                                          |            | ≤ 5                                          |  |

|                                 |    |    |  |
|---------------------------------|----|----|--|
| Burden (At both ratio)          | VA | 20 |  |
| Rated frequency                 | Hz | 50 |  |
| <b>Insulation level</b>         |    |    |  |
| AC withstand voltage 1 min. dry | kV | 28 |  |





|                                                     |                     |                 |  |
|-----------------------------------------------------|---------------------|-----------------|--|
| Impulse withstands, full wave                       | kV                  | 75              |  |
| <b>Degree of Protection</b>                         |                     |                 |  |
| Enclosure                                           |                     | IP4X            |  |
| HV Compartment                                      |                     | IP65            |  |
| LV Compartment                                      |                     | IP40            |  |
| <b>Bus bar</b>                                      |                     |                 |  |
| Material                                            |                     | Copper          |  |
| Cross Section                                       | m<br>m <sup>2</sup> | To be mentioned |  |
| <b>Dimension and Weight</b>                         |                     |                 |  |
| Height                                              | m<br>m              | To be mentioned |  |
| Width                                               | m<br>m              | To be mentioned |  |
| Depth                                               | m<br>m              | To be mentioned |  |
| Weight including Circuit Breaker                    | Kg<br>.             | To be mentioned |  |
| <b>Voltage Transformer</b>                          |                     |                 |  |
| Number of phases                                    |                     | To be mentioned |  |
| Rated primary voltage                               | kV                  | $11/\sqrt{3}$   |  |
| Rated secondary voltage                             | V                   | $110/\sqrt{3}$  |  |
| Rated burden (both Metering & Protection)           | VA                  | 50              |  |
| Accuracy class for metering                         |                     | 0.2             |  |
| Accuracy class for protection                       |                     | 3P              |  |
| <b>Power Fuse</b>                                   |                     |                 |  |
| Rated voltage                                       | kV                  | 12              |  |
| Rated current                                       | A                   | To be mentioned |  |
| Rated short Ckt. breaking current, 3 Sec.           | kA                  | 31.5            |  |
| <b>BUS SECTIONALIZER SWITCHGEAR UNIT WITH RISER</b> |                     |                 |  |
| Manufacturer's Name & Address                       |                     | To be mentioned |  |
| Applied standard                                    |                     | To be mentioned |  |
| Rated nominal voltage                               | kV                  | 11              |  |
| Rated Voltage                                       | kV                  | 12              |  |
| Rated current for bus                               | A                   | 2000            |  |
| Rated short time current                            | kA                  | 31.5            |  |
| Short time current rated duration                   | Sec.                | 3               |  |
| <b>Circuit Breaker:</b>                             |                     |                 |  |
| Type                                                |                     | VCB             |  |

|                                                                                     |                 |                                                      |  |
|-------------------------------------------------------------------------------------|-----------------|------------------------------------------------------|--|
| Vacuum Interrupter –<br>Country of<br>Origin and Manufacture<br>(Shall be the same) |                 | UK/USA/EU/Japan/Canada/<br>Australia/<br>Switzerland |  |
| Rated Voltage                                                                       | kV              | 12                                                   |  |
| Rated Current                                                                       | A               | 2000                                                 |  |
| Rated short Ckt. breaking<br>current,<br>3 Sec.                                     | kA              | 31.5                                                 |  |
| Rated short Ckt. making<br>current                                                  | kA              | 80                                                   |  |
| First pole to clear factor                                                          |                 | 1.5                                                  |  |
| Rated breaking time                                                                 | Cycle           | < 3                                                  |  |
| Opening time                                                                        | ms              | ≤ 60                                                 |  |
| Closing time                                                                        | ms              | ≤ 70                                                 |  |
| Contact resistance                                                                  | μΩ              | < 40                                                 |  |
| No of Operation<br>a) At Rated short circuit<br>current<br>b) At rated current      | Nos<br>Nos      | 100<br>30000                                         |  |
| Rated operating<br>sequence                                                         |                 | 0-0.3 sec-CO-3 min-<br>CO                            |  |
| Control voltage                                                                     | V               | DC 110                                               |  |
| Motor voltage for spring<br>charge                                                  | V               | AC 180-240                                           |  |
| No. of Trip coil                                                                    | No.             | 02                                                   |  |
| <b>Current Transformer:</b>                                                         |                 |                                                      |  |
| Rated Voltage                                                                       | kV              | 12                                                   |  |
| Accuracy class,<br>Protection                                                       |                 | 5P20                                                 |  |
| Accuracy class, Metering                                                            |                 | 0.2S                                                 |  |
| Rated current ratio                                                                 | A               | 2000-1000:5-5                                        |  |
| Factor of security                                                                  |                 | ≤ 5                                                  |  |
| Burden (At both ratio)                                                              | VA              | 20                                                   |  |
| Rated frequency                                                                     | Hz              | 50                                                   |  |
| <b>Insulation level:</b>                                                            |                 |                                                      |  |
| AC withstand voltage 1<br>min. dry                                                  | kV              | 28                                                   |  |
| Impulse withstands, full<br>wave                                                    | kV              | 75                                                   |  |
| <b>Degree of Protection</b>                                                         |                 |                                                      |  |
| Enclosure                                                                           |                 | IP4X                                                 |  |
| HV Compartment                                                                      |                 | IP65                                                 |  |
| LV Compartment                                                                      |                 | IP40                                                 |  |
| <b>Busbar:</b>                                                                      |                 |                                                      |  |
| Material                                                                            |                 | Copper                                               |  |
| Cross Section                                                                       | mm <sup>2</sup> | To be mentioned                                      |  |
| <b>Dimension and Weight</b>                                                         |                 |                                                      |  |
| Height                                                                              | mm              | To be mentioned                                      |  |

|                                                                            |       |                                                |  |
|----------------------------------------------------------------------------|-------|------------------------------------------------|--|
| Width                                                                      | mm    | To be mentioned                                |  |
| Depth                                                                      | mm    | To be mentioned                                |  |
| Weight including Circuit Breaker                                           | kg    | To be mentioned                                |  |
| <b>LINE FEEDER SWITCHGEAR UNITS</b>                                        |       |                                                |  |
| Manufacturer's Name & Address                                              |       | To be mentioned                                |  |
| Applied standard                                                           |       | To be mentioned                                |  |
| Rated nominal voltage                                                      | kV    | 11                                             |  |
| Rated Voltage                                                              | kV    | 12                                             |  |
| Rated current for bus                                                      | A     | 2000A                                          |  |
| Rated short time current                                                   | kA    | 31.5                                           |  |
| Short time current rated duration                                          | Sec   | 03                                             |  |
| <b>Circuit Breaker:</b>                                                    |       |                                                |  |
| Type                                                                       |       | VCB                                            |  |
| Vacuum Interrupter – Country of Origin and Manufacture (Shall be the same) |       | UK/USA/EU/Japan/Canada/ Australia/ Switzerland |  |
| Rated Voltage                                                              | kV    | 12                                             |  |
| Rated Current                                                              | A     | 630                                            |  |
| Rated short Ckt. breaking current, 3 Sec                                   | kA    | 31.5                                           |  |
| Rated short Ckt. making current                                            | kA    | 80                                             |  |
| First pole to clear factor                                                 |       | 1.5                                            |  |
| Rated breaking time                                                        | Cycle | < 3                                            |  |
| Opening time                                                               | ms    | ≤ 60                                           |  |
| Closing time                                                               | ms    | ≤ 70                                           |  |
| Contact resistance                                                         | μΩ    | < 40                                           |  |
| No of Operation                                                            |       |                                                |  |
| a) At Rated short circuit current                                          | Nos   | 100                                            |  |
| b) At rated current                                                        | Nos   | 30000                                          |  |
| Rated operating sequence                                                   |       | 0-0.3 sec-CO-3 min-CO                          |  |
| Control voltage                                                            | V     | DC 110                                         |  |
| Motor voltage for spring charge                                            | V     | AC 180-240                                     |  |
| No. of Trip coil                                                           | No.   | 02                                             |  |
| <b>Current Transformer:</b>                                                |       |                                                |  |
| Rated Voltage                                                              | kV    | 12                                             |  |
| Accuracy class, Metering                                                   |       | 0.2S                                           |  |
| Accuracy class, Metering                                                   |       | 0.2S                                           |  |
| Accuracy class, Protection                                                 |       | 5P20                                           |  |
| Rated current ratio                                                        | A     | 600-300:5-5-5                                  |  |

|                                             |                 |                 |  |
|---------------------------------------------|-----------------|-----------------|--|
| Rated short time current, 3 Sec             | kA              | 31.5            |  |
| Factor of security                          |                 | $\leq 5$        |  |
| Burden (At both ratio)                      | VA              | 20              |  |
| Rated frequency                             | Hz              | 50              |  |
| <b>Insulation level:</b>                    |                 |                 |  |
| AC withstand voltage 1 min. dry             | kV              | 28              |  |
| Impulse withstands, full wave               | kV              | 75              |  |
| <b>Degree of Protection</b>                 |                 |                 |  |
| Enclosure                                   |                 | IP4X            |  |
| HV Compartment                              |                 | IP65            |  |
| LV Compartment                              |                 | IP40            |  |
| <b>Earthing Switch:</b>                     |                 |                 |  |
| Type                                        |                 | To be mentioned |  |
| Short Time Current, 3Secs.                  | kA              | 31.5            |  |
| <b>Busbar:</b>                              |                 |                 |  |
| Material                                    |                 | Copper          |  |
| Cross Section                               | mm <sup>2</sup> | To be mentioned |  |
| <b>Dimension and Weight</b>                 |                 |                 |  |
| Height                                      | mm              | To be mentioned |  |
| Width                                       | mm              | To be mentioned |  |
| Depth                                       | mm              | To be mentioned |  |
| Weight including Circuit Breaker            | kg.             | To be mentioned |  |
| Type                                        |                 | To be mentioned |  |
| <b>Busbar:</b>                              |                 |                 |  |
| Material                                    |                 | Copper          |  |
| Cross Section                               | mm <sup>2</sup> | To be mentioned |  |
| Rated nominal voltage                       | kV              | 11              |  |
| Rated Voltage                               | kV              | 12              |  |
| Rated current for bus                       | A               | 2000            |  |
| Rated short time current                    | kA              | 31.5            |  |
| Short time current rated duration           | Sec.            | 3               |  |
| <b>VOLTAGE TRANSFORMER SWITCHGEAR UNITS</b> |                 |                 |  |
| Number of phases                            |                 | To be mentioned |  |
| Rated primary voltage                       | kV              | $11/\sqrt{3}$   |  |
| Rated secondary voltage                     | V               | $110/\sqrt{3}$  |  |
| Rated burden (both Metering & Protection)   | VA              | 50              |  |
| Accuracy class for metering                 |                 | 0.2             |  |
| Accuracy class for protection               |                 | 3P              |  |

|                                           |     |                 |  |
|-------------------------------------------|-----|-----------------|--|
| <b>Power Fuse:</b>                        |     |                 |  |
| Rated voltage                             | kV  | 12              |  |
| Rated current                             | A   | To be mentioned |  |
| Rated short Ckt. breaking current         | kA  | 31.5            |  |
| <b>Dimension and Weight</b>               |     |                 |  |
| Height                                    | mm  | To be mentioned |  |
| Width                                     | mm  | To be mentioned |  |
| Depth                                     | mm  | To be mentioned |  |
| Weight including Circuit Breaker          | kg. | To be mentioned |  |
| <b>Degree of Protection</b>               |     |                 |  |
| Enclosure                                 |     | IP4X            |  |
| HV Compartment                            |     | IP65            |  |
| LV Compartment                            |     | IP40            |  |
| Insulation Level                          | kV  | To be mentioned |  |
| All current carrying path must be copper. |     |                 |  |

# 11 kV CONTROL RELAY AND ENERGY METERING PANEL

| Section 6: Employer's Requirements                                       |                |                                                                                                                                                                                                                                                                                                |    |
|--------------------------------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Description                                                              | Unit           | BREB's Requirement                                                                                                                                                                                                                                                                             |    |
| <b>PROTECTION (OVER CURRENT &amp; EARTH FAULT RELAY)</b>                 |                |                                                                                                                                                                                                                                                                                                |    |
| Manufacturer's Name & Country                                            | -              | Siemens (Germany)/ GE (USA/UK) ABB (Sweden/Switzerland/Finland)                                                                                                                                                                                                                                |    |
| Type of relay                                                            | -              | Numerical Programmable with built-in display                                                                                                                                                                                                                                                   |    |
| Range setting                                                            |                |                                                                                                                                                                                                                                                                                                |    |
| a) Phase element of current                                              | % of CT rating | 5% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| b) Earth fault element of current                                        |                | 1% to at least 2000%                                                                                                                                                                                                                                                                           |    |
| c) Time Multiplier Setting (TMS)                                         |                | 0.025 to at least 1.5 (Step Size 0.005)                                                                                                                                                                                                                                                        |    |
| Ranges of timing at DMT                                                  | Sec            | 0-100 (with 1ms interval)                                                                                                                                                                                                                                                                      |    |
| Language                                                                 |                | English                                                                                                                                                                                                                                                                                        |    |
| Relay Auxiliary Voltage                                                  | V              | Minimum 88-250V DC and Minimum 115-250V AC                                                                                                                                                                                                                                                     |    |
| Nominal Current                                                          | A              | Operable in 1A & 5A (User Settable)                                                                                                                                                                                                                                                            |    |
| Minimum No of LEDs                                                       | Nos            | 10 (Programmable)                                                                                                                                                                                                                                                                              |    |
| HMI                                                                      |                | Front mounted, should be suitable to access all functions, settings and stored records without external computer                                                                                                                                                                               |    |
| Software Requirement                                                     |                | a) Should be able to configure, operate and monitor with user friendly engineering and disturbance handling tool.<br>b) Necessary software for configuration, disturbance handling and parameterization has to be supplied free of cost and without any time-bounded license with probe/cable. | c) |
| Event Record & Oscillographic Disturbance Records                        |                | Event recorder should keep at least 20 Nos previous records and disturbance recorder should handle all analogue channels and binary channels                                                                                                                                                   |    |
| Standard Protocol                                                        | -              | IEC 61850                                                                                                                                                                                                                                                                                      |    |
| Protection Feature                                                       | -              | Non-directional & Directional (for Incomer)                                                                                                                                                                                                                                                    |    |
| Test Terminal Block (TTB) for OC & EF Relay (incl. male and female part) |                | Yes                                                                                                                                                                                                                                                                                            |    |

|                                                                                             |      |                 |  |
|---------------------------------------------------------------------------------------------|------|-----------------|--|
| Standard                                                                                    |      | IEC 60255       |  |
| Bay control unit should have available                                                      | -    | Yes             |  |
| Minimum No of Binary Input                                                                  | Nos. | 16              |  |
| Minimum No of Binary Output                                                                 | Nos. | 10              |  |
| IEC 61850 communication Protocol Supported                                                  |      | To be provided  |  |
| Sync Check function                                                                         |      | To be mentioned |  |
| U, I, P, Q, S, f, PF monitoring                                                             |      | Yes             |  |
| No of Communication Ports (rear) (Minimum 1 Optical Ports with redundancy must be provided) |      | To be mentioned |  |

|                                                                                 |      |                                                                                            |  |
|---------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------|--|
| <b>Trip Relay (Separate Relay for each Numerical Relay)</b>                     |      |                                                                                            |  |
| Manufacturer's Name                                                             |      | To be mentioned                                                                            |  |
| Place of Manufacture                                                            |      | UK/USA/EU/Japan/Canada/Australia/Switzerland                                               |  |
| Manufacturer's Model Number                                                     |      | To be mentioned                                                                            |  |
| Type of Relay                                                                   |      | To be mentioned                                                                            |  |
| Maximum Operating Time                                                          | ms   | 10                                                                                         |  |
| Minimum No of Contact (NO + NC)                                                 | Nos  | 6 + 6                                                                                      |  |
| Hand & Electrical reset mechanism                                               |      | Yes                                                                                        |  |
| Rated voltage                                                                   | V DC | 88-125V                                                                                    |  |
| <b>Trip Circuit Supervision (TCS) Relay (Separate Relay for each trip coil)</b> |      |                                                                                            |  |
| Manufacturer's Name                                                             |      | Siemens/ABB/Alstom/GE                                                                      |  |
| Manufacturer's Model Number                                                     |      | To be mentioned                                                                            |  |
| Type of Relay                                                                   |      | To be mentioned                                                                            |  |
| Design                                                                          |      | Modular type                                                                               |  |
| <b>Ampere Meters</b>                                                            |      |                                                                                            |  |
| Manufacturer's Name                                                             |      | Siemens/ABB/GE/CEWE/Schlumberge AEG/Alstom                                                 |  |
| Manufacturer's Model Number                                                     |      | To be mentioned                                                                            |  |
| Type of meter                                                                   |      | Digital                                                                                    |  |
| Class of accuracy                                                               |      | 0.5                                                                                        |  |
| Separate meter for each phase                                                   |      | Yes                                                                                        |  |
| Instantaneous rated current                                                     |      | To be mentioned                                                                            |  |
| ISF                                                                             |      | Minimum 10                                                                                 |  |
| <b>Volt Meters with Selector Switch</b>                                         |      |                                                                                            |  |
| Manufacturer's Name                                                             |      | Siemens/ABB/GE/CEWE/Schlumberger/AEG/Alstom                                                |  |
| Manufacturer's Model Number                                                     |      | To be mentioned                                                                            |  |
| Type of meter                                                                   |      | Digital                                                                                    |  |
| Class of accuracy                                                               |      | 0.5                                                                                        |  |
| <b>Multifunction Meter (kW, kWh, kVARh, Voltage, Current, PF, Frequency)</b>    |      |                                                                                            |  |
| Manufacturer's name & Country                                                   |      | Siemens(Germany/Switzerland)/Alstom (UK)/ABB(Finland/Switzerland)/AEG (Germany)/Schlumberg |  |



|                                                           |      |                                                                                                                                                               |  |
|-----------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                           |      | er(USA)/CEWE<br>(UK/Italy)                                                                                                                                    |  |
| Model Number                                              | -    | To be<br>mentioned                                                                                                                                            |  |
| Number of Meters                                          | Nos. | Multifunction meter<br>containing (3 nos<br>Ammeter, 3 nos<br>voltmeter, 1 nos kW<br>meter, 1 nos kVAR<br>meter, 1 nos PF<br>meter, 1 nos<br>frequency meter) |  |
| Type of meter                                             | -    | Digital                                                                                                                                                       |  |
| Class of accuracy                                         | -    | 0.2                                                                                                                                                           |  |
| Export & Import Metering                                  |      | Export &<br>Import                                                                                                                                            |  |
| <b>Multi tariff programmable Energy meter (kWh Meter)</b> |      |                                                                                                                                                               |  |
| Manufacturer's name &<br>Country                          |      | Siemens<br>(Germany/Switzerland)/<br>Alstom (UK)/ABB<br>(Sweden)/AEG<br>(Germany)/<br>Schlumberger<br>(USA)/Landis Gyr                                        |  |

|                                                                              |          |                                                                                                                                                                                                                                                                                                                              |  |
|------------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                                              |          | (Switzerland/Greece)/CEWE<br>(UK/Italy)                                                                                                                                                                                                                                                                                      |  |
| Model Number                                                                 | -        | To be mentioned                                                                                                                                                                                                                                                                                                              |  |
| Number of KWh Meters                                                         | Nos.     | 1                                                                                                                                                                                                                                                                                                                            |  |
| Class of accuracy                                                            | -        | 0.2S                                                                                                                                                                                                                                                                                                                         |  |
| Installation                                                                 |          | Indoor installation                                                                                                                                                                                                                                                                                                          |  |
| Number of element                                                            |          | 3 (Three)                                                                                                                                                                                                                                                                                                                    |  |
| Nominal Voltage                                                              | V        | 110                                                                                                                                                                                                                                                                                                                          |  |
| Construction/connection                                                      |          | 3-Phase 4-wire solidly<br>grounded neutral                                                                                                                                                                                                                                                                                   |  |
| Export & Import Metering                                                     |          | Export & Import                                                                                                                                                                                                                                                                                                              |  |
| Nominal Rated Current                                                        | A        | Both 1A and 5A                                                                                                                                                                                                                                                                                                               |  |
| Type of the meter                                                            |          | Numerical<br>Programma<br>ble, Multifunction with accuracy<br>Class 0.2S, Load profile,<br>instrumentation profile for<br>minimum 1 yr with an interval of 30<br>min, software for protection and<br>optical probe for data download as<br>per IEC with provision of<br>communication port automatic<br>meter reading (AMR). |  |
| Starting Current                                                             | mA       | 0.1% of Nominal Current                                                                                                                                                                                                                                                                                                      |  |
| Losses at Nominal Load                                                       |          |                                                                                                                                                                                                                                                                                                                              |  |
| a) Current Circuit                                                           | W, VA    | To be mentioned                                                                                                                                                                                                                                                                                                              |  |
| b) Voltage Circuit                                                           | W, VA    | To be mentioned                                                                                                                                                                                                                                                                                                              |  |
| Meter Constant                                                               | Imp./kWh | To be mentioned                                                                                                                                                                                                                                                                                                              |  |
| Integration Period                                                           |          | 30 (Thirty) Minutes                                                                                                                                                                                                                                                                                                          |  |
| Battery Service life and<br>shelf Life (minimum)                             | Years    | 10 (ten) & 15 (fifteen)                                                                                                                                                                                                                                                                                                      |  |
| Meter Service Life (Min)                                                     | Years    | 15 (fifteen)                                                                                                                                                                                                                                                                                                                 |  |
| Meter sealing condition                                                      |          | Hermetically or Ultrasonic<br>welded (means break to<br>open)                                                                                                                                                                                                                                                                |  |
| Memory Storage                                                               | MB       |                                                                                                                                                                                                                                                                                                                              |  |
| i) No of Power<br>Interruption with Date &<br>Time                           |          | Yes                                                                                                                                                                                                                                                                                                                          |  |
| ii) Latest Power Failure-<br>Time & Date                                     |          | Yes                                                                                                                                                                                                                                                                                                                          |  |
| iii) Event logs                                                              |          | Yes                                                                                                                                                                                                                                                                                                                          |  |
| iv) Cumulative kWh,<br>kVARh (Q1 + Q4)<br>Reading for previous two<br>months |          | Yes                                                                                                                                                                                                                                                                                                                          |  |
| v) Load profile with 30 min<br>interval at least 01 (One)<br>year for:       |          |                                                                                                                                                                                                                                                                                                                              |  |
| a) kWh, kVARh (Q1+Q4)                                                        |          | Yes                                                                                                                                                                                                                                                                                                                          |  |
| b) Phase Voltage or Vh                                                       |          | Yes                                                                                                                                                                                                                                                                                                                          |  |

|                                                                 |      |                                                           |  |
|-----------------------------------------------------------------|------|-----------------------------------------------------------|--|
| c) Phase Amps or Ah                                             |      | Yes                                                       |  |
| Communication Facilities                                        |      | RS 232, RS 485, RJ45, GSM-GPRS<br>and Modbus or IEC 61850 |  |
| GSM-GPRS Modem                                                  |      | Plug and Play 4G<br>Communication<br>Module               |  |
| Optical Probe & TTB(incl. male & female part)                   |      | To be provided                                            |  |
| <b>Annunciator</b>                                              |      |                                                           |  |
| Manufacturer's Name                                             |      | To be mentioned                                           |  |
| Country of Origin                                               |      | To be mentioned                                           |  |
| Manufacturer's Model Number                                     |      | To be mentioned                                           |  |
| Windows                                                         | Nos. | Minimum 12                                                |  |
| Built in buzzer and buttons for accept, mute, test, reset, etc. |      | Yes                                                       |  |
| Mounting of Relays and Meters                                   |      | All Relay and Meter shall be flush mounted                |  |

## LV AC Distribution Panel

Vermin and dust proof, completely metal enclosed by sheet steel (11 SWG) with necessary reinforcement, color, Grey with appropriate spray-painting, free-standing type, compact in size, suitable for opening at the back by hinged door with locking device.

There shall be a 3 phase 400 A, 1 kV bus (Cu) arrangement with neutral. Bus being connected with the following MCCB's and instrument:

Voltmeter with 6-position selector switch connected to the bus.

2 × 400A, 4 pole MCCB being interlocked with each other, operative one at a time to bring the input Power to the Bus. Both these incoming feeders shall have 3 x ammeter (each).

2 × 100A, 3 pole MCCB as outgoing. 10

× 60A, 3 pole MCCB as outgoing. 10 ×

30A, 3 pole MCCB as outgoing.

The following MCCB & MCB size is the minimum expected and is provided as a guide only. The Contractor shall provide the detailed calculations of the loads and the expected loadings and the sizing of the MCCB/MCB for approval before implementation.

All MCCB's are provided with over load setting and short circuit tripping device. The ACDB panel must be furnished with a good amount of spare MCCB/MCB for further use or design purpose. There shall be a 3-φ 4-wire class 0.2 energy meter for recording the station use. Necessary amount of Voltmeter and Ammeter needs to be provided with digital display type. Instrument transformers related to metering purpose should have accuracy class of 0.2. Necessary terminal blocks and glands/openings shall be provided for the entry of suitable cables.

All equipment/instruments inside the panel shall be arranged neatly and sufficient space shall be provided for easy approach to each equipment/instrument.

Thermostat controlled panel heater, bulb for inside illumination of panel shall be provided. All other features as stated in the table of guaranteed data schedule shall applicable also.

## DC Distribution Panel

The switchboard shall comply with the requirements of BS 5468 (IEC 60439)

The distribution switchboard shall be of the cubicle type or otherwise incorporated in the cubicles for battery chargers. Double pole switches and fuses or switch fuses (miniature circuit breakers to BS 4752 or IEC 60127 may only be used if it can be shown that there will be no discrimination problems with sub-circuits) shall be fitted to the DC switchboard as required by substation services but, as a minimum requirement, that set out in the Schedule A of Requirements.

Distribution panels shall be mounted adjacent to the charger control panel and shall be of the cubicle type complying with the general requirements of cubicle type control panels. No equipment associated with the chargers shall be installed in the distribution board .

Distribution panels shall incorporate double-pole switches for each of the outgoing DC circuits and double-pole isolators for the incoming DC supplies. The panel shall be provided with a voltmeter and center zero ammeter on each incoming circuit.

A double pole switch or contactor shall be provided for the purpose of sectionalizing the busbar. A battery earth fault detecting relay, which will center tap the system via a high resistance, shall be incorporated in the distribution panel.

A low voltage detecting device for the system shall be incorporated in the distribution panel. No-volt relays will not be accepted for these devices. The voltage setting shall be adjustable over an approved range.

In addition to any other requirements specified elsewhere, the battery earth fault detecting relays and low voltage devices shall each have three alarm contacts, one for local visual annunciation, one for the station control panel alarm indication and one for potential free contact for external supervisory alarms. A lamp test facility shall be provided.

Connections between the battery and the distribution cubicle shall be made in PVC insulated cable as required. Cable laid in runs where it may be subject to damage shall be protected by wire armoring, be sheathed overall and be cleated to walls as required.

Cable boxes or glands shall be provided as appropriate for all incoming and outgoing circuits of the distribution switchboard and associated battery chargers. Each circuit shall be suitably labelled at the front of the panel and at the cable termination where the terminals shall be additionally identified.

Charging and distribution switchboards shall be provided with an earthing bar of hard drawn high conductivity copper which shall be sized to carry the prospective earth fault current without damage or danger.

Necessary amount of Voltmeter and Ammeter needs to be provided with digital display type. The DCDB panel must be furnished with a good amount of spare MCCB/MCB for further use or design purpose.

construction, insect and vermin proof, having front facing doors allowing maximum access to the working parts, when open. The design of the cubicles for the chargers shall be such as to prevent the ingress of dust and minimize the spread of flames or ionized zones, shall be to IEC 60529 IP52, but at the same time shall provide all necessary ventilation and cooling. The design of the frames shall allow the clamping and holding of all chokes, transformers and similar sources of vibration, so that vibration will be minimized, satisfy relevant standards, and not limit the life of the equipment. The frame shall allow the fixing of lifting and so that the equipment remains properly mechanically supported whilst being transported, lifted and installed.

# TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE

## LV AC / DC Distribution Panel

| S/<br>L                      | Description                           | Unit               | Employer Requirement                                                                                                                                                                                                          |  |
|------------------------------|---------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>DC DISTRIBUTION PANEL</b> |                                       |                    |                                                                                                                                                                                                                               |  |
| 1                            | Manufacturer's name & country         |                    | To be mentioned                                                                                                                                                                                                               |  |
| 2                            | Rated normal current of Bus-bar       | A                  | 200                                                                                                                                                                                                                           |  |
| 3                            | No. and size of fuse circuits         | nos./ A            | To be mentioned                                                                                                                                                                                                               |  |
| 4                            | Thickness of sheet steel (enclosure ) | mm                 | To be mentioned                                                                                                                                                                                                               |  |
| 5                            | Dimension                             | mm x<br>mm x<br>mm | To be mentioned                                                                                                                                                                                                               |  |
| 6                            | Weight                                | Kg                 | To be mentioned                                                                                                                                                                                                               |  |
| 7                            | MCCB & MCB                            |                    |                                                                                                                                                                                                                               |  |
|                              | a) Manufacturer's Name                |                    | To be mentioned                                                                                                                                                                                                               |  |
|                              | b) Place of Manufacturer              |                    | UK/USA/EU/Japan/Canada/ Australia/ Switzerland/Other eligible countries may be accepted where equivalent quality(Please see the instruction,Section-3)can be demonstrated(Acceptance of equivalency will dependo on employer) |  |
|                              | c) Manufacturer's model no.           |                    | To be mentioned                                                                                                                                                                                                               |  |
|                              | d) Rated voltage                      |                    | To be mentioned                                                                                                                                                                                                               |  |
|                              | e) Rated current                      |                    | To be mentioned                                                                                                                                                                                                               |  |
| 8                            | Ammeter and Voltmeter Type            |                    | Digital                                                                                                                                                                                                                       |  |
| <b>AC DISTRIBUTION PANEL</b> |                                       |                    |                                                                                                                                                                                                                               |  |
| 1                            | Manufacturer's name & country         |                    | To be mentioned                                                                                                                                                                                                               |  |
| 2                            | Rated normal current of Bus-bar       | A                  | 400                                                                                                                                                                                                                           |  |
| 3                            | No. and size of fused circuits        | nos/ A             | 3                                                                                                                                                                                                                             |  |
| 4                            | Thickness of sheet steel (enclosure ) | mm                 | 4                                                                                                                                                                                                                             |  |

|   |                                   |                                  |                                                                                                                                                                                                                                                    |  |
|---|-----------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 5 | Dimension                         | m<br>m<br>x<br>m<br>m<br>x<br>mm | To be mentioned                                                                                                                                                                                                                                    |  |
| 6 | Weight                            | Kg                               | To be mentioned                                                                                                                                                                                                                                    |  |
| 7 | MCCB & MCB                        |                                  |                                                                                                                                                                                                                                                    |  |
|   | a)<br>Manufacturer's<br>Name      |                                  | To be mentioned                                                                                                                                                                                                                                    |  |
|   | b) Place of<br>Manufacturer       |                                  | UK/USA/EU/Japan/Canada/ Australia/<br>Switzerland/Other eligible countries may<br>be accepted where equivalent<br>quality(Please see the<br>instruction,Section-3)can be<br>demonstrated(Acceptance of equivalency<br>will<br>dependo on employer) |  |
|   | c)<br>Manufacturer's<br>model no. |                                  | To be mentioned                                                                                                                                                                                                                                    |  |
|   | d) Rated voltage                  |                                  | To be mentioned                                                                                                                                                                                                                                    |  |





|   |                               |  |                 |  |
|---|-------------------------------|--|-----------------|--|
|   | e) Rated current              |  | To be mentioned |  |
| 8 | Energy Meter                  |  | To be provided  |  |
| 9 | Ammeter and<br>Voltmeter Type |  | Digital         |  |

PUBLICATION 266-1999  
RURAL ELECTRIFICATION BOARD (REB)  
PEOPLES REPUBLIC OF BANGLADESH

STANDARD FOR  
**36 KV UNDERGROUND POWER CABLE**

## **1. GENERAL**

This standard establishes the physical and electrical requirements for 36 KV, 1-Core, copper conductor, cross-linked polyethylene (XLPE) insulated power cable shall comply with IEC-60502. The cable shall be suitable in all respect for use in 33 KV system, 50 hertz, underground distribution system.

## **2. REFERENCE DATA:**

REB 36 KV, 1- core underground cable shall be comprised of the following:

### **2.1 CONDUCTOR.**

The conductor shall be stranded, circular and compacted copper wire in accordance with IEC-228 or ASTM B3.

### **2.2 CONDUCTOR SCREEN**

The conductor screen shall comprise of a layer of extruded semi-conducting compound, compatible in all respects with the conductor and insulation material. Conductor screen shall be bonded to the insulation such a way that no voids or discontinuities are present. The bond shall be adequate to withstand normal electrical and mechanical stresses in service without degradation or separation.

Lapped semi-conducting tape shall not be used for conductor screens.

### **2.3 INSULATION**

The insulation shall be cross-linked polyethylene (XLPE). The cable insulation shall be extruded in one operation with conductor & insulation screens. The highest possible purity of insulation material is required. The Bidder shall demonstrate that adequate precautions are taken to remove contaminants and to eliminate the introduction of particles of contaminate during material handling or the extrusion process.

The insulation material shall consist of cross-linked polyethylene tightly extruded over the conductor screen. A cross-linking process using steam curing will not be permitted. Dry process using the Catenary Continuous Vulcanization or the Vertical Continuous Vulcanization insulation shall be offered, without which the Bid will not considered.

### **2.4 INSULATION THICKNESS**

The insulation thickness of the cables shall not be less than the values tabulated in IEC publication 60502. Insulation thickness shall not depart from the specified nominal value by an amount exceeding the tolerance specified in IEC publication-60502.

The thickness of the semi conducting screens on the conductors and over the insulation shall not be included in the measurement of insulation thickness.

### **2.5 INSULATION SCREEN**

The insulation screen shall comprise of a non-metallic semi-conducting polyethylene part in combination with a metallic part.

The non-metallic semi-conducting part shall be applied directly upon the insulation of each core and shall comprise of a layer of extruded semi-conducting polyethylene compound.

The conductor screen, Insulation and semi-conducting part of Insulation screen layer shall be applied to the conductor in common extrusion process with dry curing system.

The metallic part shall be stranded copper applied directly over the semi-conducting part. It shall comprise of a single layer of copper wires equally spaced apart.

## **2.6 ARMOUR**

The armour shall consist of a single layer of non-magnetic wires (aluminum alloy wire) in accordance with IEC-60502. The armour wires shall cover the whole diameter of the cable.

The non-magnetic wire joints are brazed or welded and any wire shall be not less than 1 mm from nearest joints in any other armour wire in the complete cable.

## **2.7 OVER SHEATH**

The cable shall be sheathed overall with a MDPE (medium density polyethylene) outer sheath. The outer sheath shall be of smooth and uniform composition and free of holes. Cracks blisters and imperfection. The external jacket shall be loaded with 2.5% carbon black for UV resistance.

As a protection against termite attack, the outer covering shall contain termite repellent substance of Pb nephtanate.

The outer sheath shall be of adequate strength and thickness to withstand the test voltages and mechanical tests and shall be suitable for the ambient conditions at site.

The outer sheath material shall be capable of withstanding without damage or deformation the highest temperature achieved with the cable at its rated current and at the site ambient conditions.

## **2.8 MANUFACTURER'S IDENTIFICATION.**

The manufacturer's identification shall be printed with white color on the identifying tape. It shall show the rated voltage, conductor size, year of manufacturing and name of the manufacturer at an interval of not more than 1000 mm throughout the length of the cable. The designation of voltage and cable marking shall also be embossed on the outer MDPE covering. The gap between the end of one set of embossed characters and the beginning of the next shall be not greater than 150 mm throughout the length of cable with character approximately 10 mm high.

Name of the purchaser shall be embossed in the title- RURAL ELECTRIFICATION BOARD at every 1000 mm gap.

## **2.9 CONTINUOUS CURRENT RATING:**

The continuous rating of the cables that the bidder proposes to supply shall be calculated by means of the procedure described in IEC publication 287 based on the site ambient conditions including solar radiation, with the installation parameters as specified.

The maximum conductor temperature shall not exceed 90° C when carrying the rated current under the most onerous site conditions.

The bidder shall base his ratings on the site ambient conditions, with the methods of installation and bonding as specified. Due account shall be taken of the heating due to other cables or other sources of heat where these can be identified. The bidder shall state all the parameters including any assumptions that he has made in the calculation of continuous current ratings.

## **2.10 SHORT CIRCUIT RATING:**

All cables shall be capable of withstanding without damage or permanent distortion the specified maximum short circuit currents for the specified times as under: -

The temperature of the conductors during the passage of the specified maximum fault current for the specified time of one second shall not exceed 250° C for XLPE cables.

The cable design including the design of external Clamps or other restraining devices shall be adequate to contain the mechanical forces arising from two or three phase short circuit currents and longitudinal forces whether arising from magnetic effects or from thermal expansion of conductors.

The cable metallic screen sheath and armor shall be capable of passing earth fault current for the specified time of one second without damage, permanent distortion or deterioration in the cable. The metallic screen shall be capable of carrying an earth fault current without damage as per table-2 of the specification.

If in order to comply with the requirement for carrying prospective earth fault current it is necessary to rely on the armor and/ or sheath conductivity in addition to metallic core screen tapes, the bedding material or materials shall be of the semi-conducting type.

## **3. TESTS:**

### **3.1 GENERAL**

The following tests shall be carried out to demonstrate the integrity of the cable. The frequency of the alternating current supply is between 48 Hz and 62 Hz.

### **3.2 TESTS AT MANUFACTURER'S WORKS**

Tests shall be carried out in accordance with the relevant British standards IEC publication and the following type tests and routine tests shall be carried out at the Manufacturer's works.

#### **a) TYPE TESTS**

Type test for 36 KV cables shall be carried out in accordance with the IEC publication 540 and 60502 for suitable length of cable.

#### **i) ELECTRICAL TESTS**

1. Partial Discharge test (s).
2. Bending test.
3. Heat cycle test.
4. Impulse Voltage withstand test
5. High voltage Alternating current test

## **II) NON-ELECTRICAL TEST**

1. Measurement of Insulation thickness
2. Measurement of thickness of non-metallic sheath.
3. Determination of mechanical properties of insulation and sheaths before and after aging.
4. Ageing test on pieces of complete cables.
5. Pressure test at high temperature on insulation & sheaths.
6. Hot set test.
7. Water absorption test on insulations.
8. Shrinkage test on XLPE insulation.
9. Electrical test after installation.
10. Water penetration test.

**b) ROUTINE TESTS:**

The manufacturer shall carry out routine tests on all finished cables to demonstrate their individual integrity as per IEC pub. 60502

1. Measurement of Electrical Resistance of conductors.
2. High voltage test
3. Partial discharge test

### **3.3 SPECIAL TEST**

Additional samples of cable shall be selected for special tests. The number and frequency of special tests shall be in accordance with the procedures specified in IEC publication 60502.

The cable shall be subjected to the following special tests.

1. Conductor examination
2. Check of dimensions
3. Electrical test for cables
4. Hot set test.

## **4. PACKING**

Cable shall be shipped on standard non-returnable steel drum, each drum having stenciled on its side; Size, Type, and length of cable, gross & net weight and contract number. The complete cable drum shall be covered by steel sheet to protect from external thrust and the kits are to be export-packed and properly protected for shipment, rough transportation and storage.

The maximum length of cable on a drum shall be 500-1500 meters with a variation of + / - 10 % (ten percent) which should be finalized during drawing approval and it shall be only one length of conductor on a reel.

Each kits cartoon shall be sealed in water proof polyethylene bag having a silica gel packet placed inside the unit and then packed in polystyrene foam gasket closed by self-adhesive tape. Size of the items shall be marked by label on the foam for easy identification. Maximum 10 (ten) sets kits are allowed to pack into separate wooden packing box lined with heavy gauge polyethylene.

## **5. DOCUMENTATION**

The following test reports and the attached data schedule filled in completely shall be included with offer, without which the offer shall not be considered for evaluation.

- a) All Routine Test, Type Test and Special Test reports as per clause 3.2a, 3.2b

& 3.3 of the specification and ISO-9001 Certificate of the identical 36KV cables from an internationally recognized independent laboratory.

- b) Supply record with documentary evidence of the identical 33KV cables for last 5 (five) years mentioning purchaser's name, quantity, and year of supply.
- c) Printed catalogue/Leaflet for the offered type of cables.

**6. GENERAL REQUIREMENT OF 33 KV XLPE UNDERGROUND CABLE**

**Table-1**

| <b>SL. No.</b> | <b>Particulars</b>                                         | <b>Specified</b>                                                                                                                             |
|----------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1.             | Installation                                               | Direct burial                                                                                                                                |
| 2.             | Type                                                       | XLPE insulated, 1-core, armoured, underground cable.                                                                                         |
| 3.             | Voltage:                                                   |                                                                                                                                              |
|                | a. Voltage between phases                                  | 33 KV                                                                                                                                        |
|                | b. Maximum system voltage                                  | 36 KV                                                                                                                                        |
| 4.             | CORES:                                                     |                                                                                                                                              |
|                | Number of cores                                            | Single core, stranded copper, round concentric.                                                                                              |
| 5.             | CONDUCTOR:                                                 |                                                                                                                                              |
|                | a. Material                                                | copper                                                                                                                                       |
|                | b. Design (stranded sectional etc.)                        | round, compacted                                                                                                                             |
|                | c. Strand                                                  | As per table-2                                                                                                                               |
|                | d. Cross sectional area of conductor core                  | As per table-2 or specified as per material & price schedule                                                                                 |
|                | e. Maximum DC resistance of conductor at 20 <sup>0</sup> C | As per table-2                                                                                                                               |
| 6.             | CONDUCTOR SCREEN:                                          |                                                                                                                                              |
|                | a. Material                                                | Extruded Semi-conducting PE                                                                                                                  |
| 7.             | INSULATION:                                                |                                                                                                                                              |
|                | a. Thickness (Nom)                                         | 8.00 mm                                                                                                                                      |
|                | b. Type of curing                                          | Dry curing                                                                                                                                   |
| 8.             | INSULATION SHIELD                                          | Extruded Semi-conducting PE                                                                                                                  |
| 9.             | ARMOUR:                                                    | A single layer of non-magnetic wire (aluminum alloy wire) in accordance with IEC 60502.                                                      |
| 10.            | OVER SHEATH                                                | Medium Density Polyethylene (MDPE)                                                                                                           |
| 11.            | STANDARDS                                                  | Design, Manufacture, Testing & Performance shall be in accordance to latest revision of IEC-60502, 540 or Equivalent International Standard. |

**Table-2**

| Rated Voltage<br>s $U_0/U$<br>( $U_m$ ) | Item No. | Conductor                         |                                | Max D.C. Resistance at 20°C ( $\Omega/\text{km}$ ) | Minimum XLPE Insulation Thickness (mm) | Short-Circuit Withstand Capacity for 1 Second (minimum) |                      |                  |
|-----------------------------------------|----------|-----------------------------------|--------------------------------|----------------------------------------------------|----------------------------------------|---------------------------------------------------------|----------------------|------------------|
|                                         |          | Cross - Section ( $\text{mm}^2$ ) | Minimum wires in the conductor |                                                    |                                        | Phase Conductor (kA)                                    | Metallic Screen (kA) | Aarmor Wire (kA) |
| 18/30<br>(36)                           | F-7      | 400                               | 53                             | 0.0470                                             | 8.0                                    | 57                                                      | 25                   | 28               |
|                                         | F-8      | 500                               | 53                             | 0.0366                                             | 8.0                                    | 71                                                      | 25                   | 32               |
|                                         | F-9      | 630                               | 53                             | 0.0283                                             | 8.0                                    | 71                                                      | 25                   | 38               |
|                                         | F-10     | 800                               | 53                             | 0.0221                                             | 8.0                                    | 71                                                      | 25                   | 45               |

## 7. TECHNICAL SPECIFICATION OF JOINTING KITS FOR 33 KV XLPE,1-CORE, COPPER CABLE

Bidder will submit the type test report of Jointing Kits from an internationally recognized independent laboratory

### 7.1. TERMINATION KITS (OUTDOOR)

| Sl. No. | Name of Item         | Termination jointing kits for 36 KV XLPE cable single-core, (Outdoor)                                                                                                                                                                                                                                                                                           |
|---------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | Application          | For 33 KV, 1 core, XLPE, copper conductor armored cable                                                                                                                                                                                                                                                                                                         |
| 2.      | Installation         | Outdoor, mounted on Poles/Structure                                                                                                                                                                                                                                                                                                                             |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia/                                                                                                                                                                                                                                                                                                           |
| 4.      | Place of Manufacture | Other eligible countries may be accepted where equivalent quality (Please see the instruction,Section-3) can be demonstrated<br>(Acceptance of equivalency will depend on Employer).                                                                                                                                                                            |
| 5.      | System               | 33 KV, effectively grounded system                                                                                                                                                                                                                                                                                                                              |
| 6.      | Cable Conductor      | As per Table-2 & material & price schedule.                                                                                                                                                                                                                                                                                                                     |
| 7.      | Kit content          | Heat shrinkable high voltage insulating and non-tracking tubing<br>Heat shrinkable stress control tubing<br>Stress relieving mastic strip<br>Truck resistant sealant tape<br>Heat shrinkable track resistant rain skirt<br>Support Insulator<br>Cable preparation kit<br>Solderless earth connection kit<br>Compression lugs<br>Support Insulators Tee brackets |



|  |  |                           |
|--|--|---------------------------|
|  |  | Installation Instructions |
|--|--|---------------------------|

## 7.2 TERMINATION KITS (INDOOR)

| Sl. No. | Name of Item         | Termination jointing kits for 36 KV XLPE cable single-core (Indoor)                                                                                                                                                                           |
|---------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | Application          | For 33 KV, 1 core, XLPE, copper conductor armored cable                                                                                                                                                                                       |
| 2.      | Installation         | For indoor switchgear terminations                                                                                                                                                                                                            |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia/<br>Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated<br>(Acceptance of equivalency will depend on Employer). |
| 4.      | Place of Manufacture |                                                                                                                                                                                                                                               |
| 5.      | System               | 33 KV, effectively grounded system                                                                                                                                                                                                            |
| 6.      | Cable Conductor      | As per Table-2 & material & price schedule.                                                                                                                                                                                                   |
| 7.      | Kit content          | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                                                                                                               |
|         |                      | Heat shrinkable stress control tubing                                                                                                                                                                                                         |
|         |                      | Stress relieving mastic strip                                                                                                                                                                                                                 |
|         |                      | Truck resistant sealant tape                                                                                                                                                                                                                  |
|         |                      | Heat shrinkable track resistant rain skirt                                                                                                                                                                                                    |
|         |                      | Cable preparation kit                                                                                                                                                                                                                         |
|         |                      | Solderless earth connection kit                                                                                                                                                                                                               |
|         |                      | Compression lugs                                                                                                                                                                                                                              |
|         |                      | Installation Instructions                                                                                                                                                                                                                     |

**7.3 STRAIGHT THROUGH JOINT BOX**

|         |                      |                                                                                                                                                                                                                                          |
|---------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sl. No. | Name of Item         | Straight through joint box for 36 KV XLPE cable, single-core copper conductor.                                                                                                                                                           |
| 1.      | Application          | For 33 KV, 1 core, XLPE, copper conductor armored cable                                                                                                                                                                                  |
| 2.      | Installation         | For underground horizontal mounting                                                                                                                                                                                                      |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia / Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |
| 4.      | Place of Manufacture |                                                                                                                                                                                                                                          |
| 5.      | System               | 33 KV, effectively grounded system                                                                                                                                                                                                       |
| 6.      | Cable Conductor      | As per Table-2 & material & price schedule.                                                                                                                                                                                              |
| 7.      | Construction         | The joint shall be proof against ingress of moisture and water.                                                                                                                                                                          |
| 8.      | Kit content          | Compression ferrules                                                                                                                                                                                                                     |
|         |                      | Valid filling tape                                                                                                                                                                                                                       |
|         |                      | Heat shrinkable stress control tubing                                                                                                                                                                                                    |
|         |                      | Truck resistant sealant tape                                                                                                                                                                                                             |
|         |                      | Heat shrinkable high voltage insulating tape                                                                                                                                                                                             |
|         |                      | Heat shrinkable black/red dual wall                                                                                                                                                                                                      |
|         |                      | Estomeric tube                                                                                                                                                                                                                           |
|         |                      | Roll spring                                                                                                                                                                                                                              |
|         |                      | Heat shrinkable outer jacket tube                                                                                                                                                                                                        |
|         |                      | Heat shrinkable truck resistant rain skirt.                                                                                                                                                                                              |
|         |                      | Cable preparation kit                                                                                                                                                                                                                    |
|         |                      | Solder less earth connection kit                                                                                                                                                                                                         |
|         |                      | Misc. other material                                                                                                                                                                                                                     |
|         |                      | Installation instructions                                                                                                                                                                                                                |

**Note 1:** The size & quantity of the termination kits and straight through joint splices shall be as per material & price schedule.

**Note 2:** A team of 03 technical personnel of BREB will visit for 03 days at manufacturer's premises / factory during manufacturing of 33KV, 1cx500 mm<sup>2</sup> XLPE (Cu) Cable and inspect the procedure of manufacturing & also inspect the item as per the required standard. The Contractor will be responsible for arranging & bearing all costs for the team including visa fees, air fares, accommodation, fooding, laundry, transportation etc. plus a daily allowance (not less than GOB standard) for each member of the team.

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

FOR 36 KV XLPE, 1-CORE, 500 MM2 COPPER CABLE

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| SI No. | Technical Particulars                          | REB Specification                                                                                                                              | Guaranteed Specification |
|--------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1      | Manufacturer & Cat. No.                        | To be mentioned                                                                                                                                |                          |
| 2      | INSTALLATION                                   | Direct burial                                                                                                                                  |                          |
| 3      | TYPE                                           | XLPE insulated, 1-core, armoured, underground cable.                                                                                           |                          |
| 4      | VOLTAGE:                                       |                                                                                                                                                |                          |
|        | a. Voltage between phases                      | 33 KV                                                                                                                                          |                          |
|        | b. Maximum system voltage                      | 36 KV                                                                                                                                          |                          |
| 5      | CORES:                                         |                                                                                                                                                |                          |
|        | Number of cores                                | Single core, stranded copper, round concentric.                                                                                                |                          |
| 6      | CONDUCTOR:                                     |                                                                                                                                                |                          |
|        | a. Material                                    | Copper                                                                                                                                         |                          |
|        | b. Design (stranded sectional etc.)            | Round, compacted                                                                                                                               |                          |
|        | c. Strand                                      | As per table-2                                                                                                                                 |                          |
|        | d. Cross sectional area of each conductor core | As per table-2 or specified in material schedule                                                                                               |                          |
|        | e. Maximum DC resistance of conductor at 200 C | As per table-2                                                                                                                                 |                          |
| 7      | CONDUCTOR SCREEN:                              |                                                                                                                                                |                          |
|        | a. Material                                    | Extruded Semi-conducting PE                                                                                                                    |                          |
| 8      | INSULATION:                                    |                                                                                                                                                |                          |
|        | a. Thickness (Nom)                             | 8.0 mm                                                                                                                                         |                          |
|        | a. Type of curing                              | Dry curing                                                                                                                                     |                          |
| 9      | INSULATION SHIELD                              | Extruded Semi-conducting PE                                                                                                                    |                          |
| 10     | METAL SHIELD                                   | Copper wire                                                                                                                                    |                          |
| 11     | INNER SHEATH                                   | Polyvinyl Chloride (PVC)                                                                                                                       |                          |
| 12     | ARMOUR                                         | Aluminum Alloy Wire.                                                                                                                           |                          |
| 13     | OUTER SHEATH                                   | Medium Density Polyethylene (MDPE)                                                                                                             |                          |
| 14     | Short Circuit Withstand Capability             | As per table-2                                                                                                                                 |                          |
| 15     | STANDARDS                                      | Design, Manufacture, Testing & Performance shall be in accordance to latest revision of IEC-60502-2, 540 or Equivalent International standard. |                          |

**Seal & Signature of the Bidder****Seal & Signature of the manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****FOR TERMINATION JOINTING KITS FOR 36 KV XLPE, 1-CORE, 500 MM2 COPPER CABLE  
(OUTDOOR)**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| <b>Sl. No</b> | <b>Technical Particulars</b> | <b>REB Specification</b>                                                                                                                                                                                                                     | <b>Guaranteed Specification</b> |
|---------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 1             | Manufacturer & Cat. No.      | To be mentioned                                                                                                                                                                                                                              |                                 |
| 2             | Application                  | For 33 KV, 1 core, XLPE, copper conductor armored cable                                                                                                                                                                                      |                                 |
| 3             | Installation                 | Outdoor, mounted on Poles/Structure                                                                                                                                                                                                          |                                 |
| 4             | Country of origin            | USA/UK/Germany/Switzerland/France/ Japan/ EU/Australia/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated<br>(Acceptance of equivalency will depend on Employer). |                                 |
| 5             | Place of Manufacture         |                                                                                                                                                                                                                                              |                                 |
| 6             | System                       | 33 KV, effectively grounded system                                                                                                                                                                                                           |                                 |
| 7             | Cable Conductor              | As per Table-2 & material & price schedule.                                                                                                                                                                                                  |                                 |
| 8             | Kit content                  | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                                                                                                              |                                 |
|               |                              | Heat shrinkable stress control tubing                                                                                                                                                                                                        |                                 |
|               |                              | Stress relieving mastic strip                                                                                                                                                                                                                |                                 |
|               |                              | Truck resistant sealant tape                                                                                                                                                                                                                 |                                 |
|               |                              | Heat shrinkable track resistant rain skirt                                                                                                                                                                                                   |                                 |
|               |                              | Support Insulator                                                                                                                                                                                                                            |                                 |
|               |                              | Cable preparation kit                                                                                                                                                                                                                        |                                 |
|               |                              | Solderless earth connection kit                                                                                                                                                                                                              |                                 |
|               |                              | Compression lugs                                                                                                                                                                                                                             |                                 |
|               |                              | Support Insulators Tee brackets                                                                                                                                                                                                              |                                 |
|               |                              | Installation Instructions                                                                                                                                                                                                                    |                                 |

**Seal & Signature of the Bidder****Seal & Signature of the manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****FOR TERMINATION JOINTING KITS FOR 36 KV XLPE, 1-CORE, 500 MM2 COPPER CABLE  
(INDOOR)**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| <b>Sl No</b> | <b>Technical Particulars</b> | <b>REB Specification</b>                                                                                                                                                                                                                 | <b>Guaranteed Specification</b> |
|--------------|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 1            | Manufacturer & Cat. No.      | To be mentioned                                                                                                                                                                                                                          |                                 |
| 2            | Application                  | For 33 KV, 1 core, XLPE, copper conductor armored cable                                                                                                                                                                                  |                                 |
| 3            | Installation                 | For indoor switchgear terminations                                                                                                                                                                                                       |                                 |
| 4            | 3) Country of origin         | USA/UK/Germany/Switzerland/France/Japan/ EU/Australia/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |                                 |
| 5            | 4) Place of Manufacture      |                                                                                                                                                                                                                                          |                                 |
| 6            | 5) System                    | 33 KV, effectively grounded system                                                                                                                                                                                                       |                                 |
| 7            | 6) Cable Conductor           | As per Table-2 & material & price schedule.                                                                                                                                                                                              |                                 |
| 8            | Kit content                  | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                                                                                                          |                                 |
|              |                              | Heat shrinkable stress control tubing                                                                                                                                                                                                    |                                 |
|              |                              | Stress relieving mastic strip                                                                                                                                                                                                            |                                 |
|              |                              | Truck resistant sealant tape                                                                                                                                                                                                             |                                 |
|              |                              | Heat shrinkable track resistant rain skirt                                                                                                                                                                                               |                                 |
|              |                              | Cable preparation kit                                                                                                                                                                                                                    |                                 |
|              |                              | Solderless earth connection kit                                                                                                                                                                                                          |                                 |
|              |                              | Compression lugs                                                                                                                                                                                                                         |                                 |
|              |                              | Installation Instructions                                                                                                                                                                                                                |                                 |

**Seal & Signature of the Bidder****Seal & Signature of the manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

FOR STRAIGHT THROUGH JOINT BOX FOR 36 KV XLPE, 1-CORE, 500 MM2 COPPER CABLE

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Sl. No. | Technical Particulars   | REB Specification                                                                                                                                                                                                                         | Guaranteed Specification |
|---------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1       | Manufacturer & Cat. No. | To be mentioned                                                                                                                                                                                                                           |                          |
| 2       | Application             | For 33 KV, 1- core, XLPE, copper conductor armored cable                                                                                                                                                                                  |                          |
| 3       | Installation            | For underground horizontal mounting                                                                                                                                                                                                       |                          |
| 4       | Country of origin       | USA/UK/Germany/Switzerland/France/ Japan/ EU/Australia/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |                          |
| 5       | Place of Manufacture    |                                                                                                                                                                                                                                           |                          |
| 6       | System                  | 33 KV, effectively grounded system                                                                                                                                                                                                        |                          |
| 7       | Cable Conductor         | As per Table-2 & material & price schedule.                                                                                                                                                                                               |                          |
| 8       | Cable Conductor         | The joint shall be proof against ingress of moisture and water.                                                                                                                                                                           |                          |
| 9       | Kit content             | Compression ferrules                                                                                                                                                                                                                      |                          |
|         |                         | Valid filling tape                                                                                                                                                                                                                        |                          |
|         |                         | Heat shrinkable stress control tubing                                                                                                                                                                                                     |                          |
|         |                         | Truck resistant sealant tape                                                                                                                                                                                                              |                          |
|         |                         | Heat shrinkable high voltage insulating tape                                                                                                                                                                                              |                          |
|         |                         | Heat shrinkable black/red dual wall                                                                                                                                                                                                       |                          |
|         |                         | Estomeric tube                                                                                                                                                                                                                            |                          |
|         |                         | Roll spring                                                                                                                                                                                                                               |                          |
|         |                         | Heat shrinkable outer jacket tube                                                                                                                                                                                                         |                          |
|         |                         | Heat shrinkable truck resistant rain skirt.                                                                                                                                                                                               |                          |
|         |                         | Cable preparation kit                                                                                                                                                                                                                     |                          |
|         |                         | Solder less earth connection kit                                                                                                                                                                                                          |                          |
|         |                         | Misc. other material                                                                                                                                                                                                                      |                          |
|         |                         | Installation instructions                                                                                                                                                                                                                 |                          |

**Seal & Signature of the Bidder****Seal & Signature of the manufacturer**

Note: If any data deviate in the GTP with the detail specification, then specification will prevail.

PUBLICATION 262-1988  
BANGLADESH RURAL ELECTRIFICATION BOARD (BREB) PEOPLES  
REPUBLIC OF BANGLADESH  
STANDARD FOR

**15 KV UNDERGROUND POWER CABLE**

**1. GENERAL**

This standard establishes the physical and electrical requirements for 15 KV, 3-Core, copper conductor, cross-linked polyethylene insulated power cable shall comply with IEC-60502. The cable shall be suitable in all respect for use in 11 KV system, 50 hertz, underground distribution system.

**2. CLIMATE CONDITIONS**

The cable subject to this specification shall be used to convey power from a 11kV overhead line via fresh or tidal submarine route to another overhead line under the following conditions:

- Altitude above sea level up to 1000 meters
- Maximum outdoor temperature: 45°C
- Minimum outdoor temperature: 0°C
- Maximum daily average temperature: 35°C
- Relative Humidity: up to 100%
- Water conditions: high turbidity, heavy scouring by sandy bed load, brackish water conditions, up to 30m depth of installation
- Frequency: 50 Hz.
- System type: 11kV Ungrounded three phase (neutral earthed at the substation)
- Installation: Three core copper conductors in a single cable.
- Average isokeraunic: 80 days/year
- Earthing and bonding: Sheaths and armour bonded and earthed at both ends.

**3. REFERENCE DATA:**

REB 15 KV, 3- core underground cable shall be comprised of the following:

**3.1 CONDUCTOR.**

The conductor shall be uncoated, class B stranded, circular and compacted copper wire in accordance with IEC-228 or ASTM B3. The copper conducted cables shall be constructed with three cores in size of as per **table-2** or specified in material schedule. The cores in any one cable shall be of equal cross-sectional areas.

**3.2 CONDUCTOR SCREEN**

The conductor screen shall comprise of a layer of extruded semi-conducting polyethylene compound, compatible in all respects with the conductor and insulation material. Conductor screen shall be bonded to the insulation such a way that no voids or discontinuities are present. The bond shall be adequate to withstand normal electrical and mechanical stresses in service without degradation or separation.





Lapped semi-conducting tape shall not be used for conductor screens.

### **3.3 INSULATION**

The insulation shall be cross-linked polyethylene (XLPE). The cable insulation shall be extruded in one operation with conductor & insulation screens. The highest possible purity of insulation material is required. The Bidder shall demonstrate that adequate precautions are taken to remove contaminants and to eliminate the introduction of particles of contaminate during material handling or the extrusion process.

The insulation material shall consist of cross-linked polyethylene tightly extruded over the conductor screen. A cross-linking process using steam curing will not be permitted. Dry process using the Catenary Continuous Vulcanization or the Vertical Continuous Vulcanization insulation shall be offered, without which the Bid will not be considered.

### **3.4 INSULATION THICKNESS**

The minimum thickness of insulation shall be (4.50 mm) for 15 KV underground cable. The thickness at any point may, be less than the specified value, provided the difference does not exceed 10 percent plus 0.1 mm.

The thickness of the semi conducting screens on the conductors and over the insulation shall not be included in the measurement of insulation thickness.

### **3.5 INSULATION SCREEN**

The insulation screen shall comprise of a non-metallic semi-conducting polyethylene part in combination with a metallic part by triple tandem process.

The non-metallic semi-conducting part shall be applied directly upon the insulation of each core and shall comprise of a layer of extruded semi-conducting polyethylene compound.

The conductor screen, Insulation and semi-conducting part of Insulation screen layer shall be applied to the conductor in common extrusion process with dry curing system.

The metallic part shall be stranded copper applied directly over the semi-conducting part.

### **3.6 Metallic Shield**

A minimum 0.2mm thick copper tape or copper wire applied over the outer screen of the each core. Shield shall provide the circuit neutral and withstand a fault current as per table-2 with initial sheath temperature of 90 degree C, and final sheath temperature of 250 degree C for each core.

### **3.7 INNER SHEATH**

The cable shall be sheathed overall with a PVC inner sheath. The inner sheath shall be of smooth and uniform composition and free of holes, Cracks and blisters and imperfection.

As a protection against termite attack, the inner covering shall contain termite repellent substance of Pb nephtanate.

The inner sheath shall be of adequate strength and thickness to withstand the test voltages and mechanical tests and shall be suitable for the ambient conditions at site.

The inner sheath material shall be capable of withstanding without damage or deformation the highest temperature achieved with the cable at its rated current and at the site ambient conditions.

### **3.8 Jacket**

The cable shall be jacketed overall with a medium density polyethylene (MDPE) outer jacket. The outer jacket shall be of smooth and uniform composition and free of holes, cracks blisters and imperfection. The jacket shall fully embed & encapsulate the armour wires.

The external jacket shall be loaded with 2.5% carbon black for UV resistance.

The outer jacket shall be of adequate strength and thickness to withstand the test voltages and mechanical tests and shall be suitable for the ambient conditions at site.

The outer jacket material shall be capable of withstanding without damage or deformation the highest temperature achieved with the cable at its rated current and at the site ambient conditions.

### **3.9 ARMOUR**

The armour shall consist of a single layer of Aluminum Alloy Wire. The armour shall cover the whole diameter of the cable.

The wire joints are brazed or welded and any wire shall be not less than 1 mm from nearest joints in any other armour wire in the complete cable.

### **3.10 MANUFACTURER'S IDENTIFICATION.**

The manufacturer's identification shall be printed with white colour on the identifying tape. It shall show the rated voltage, conductor size, year of manufacturing and name of the manufacturer at an interval of not more than 1000 mm throughout the length of the cable.

The designation of voltage and cable marking shall also be embossed on the outer MDPE covering.

The gap between the end of one set of embossed characters and the beginning of the next shall be not greater than 150 mm throughout the length of cable with character approximately 10 mm high. Each conductor shall be coded for phase identification.

Name of the purchaser shall be embossed in the title- "BANGLADESH RURAL ELECTRIFICATION BOARD" at every 1000 mm gap.

### **3.11 CONTINUOUS CURRENT RATING:**

The continuous rating of the cables that the bidder proposes to supply shall be calculated by means of the procedure described in IEC publication 287 based on the site ambient conditions including solar radiation, with the installation parameters as specified.

The maximum conductor temperature shall not exceed 90° C when carrying the rated current under the most onerous site conditions.

The bidder shall base his ratings on the site ambient conditions, with the methods of installation and bonding as specified. Due account shall be taken of the heating due to other cables or other sources of heat where these can be identified. The bidder shall state all the parameters including any assumptions that he has made in the calculation of continuous current ratings.

Temperature ratings the cable is given below:

|                    |        |
|--------------------|--------|
| Normal operation   | :90°C  |
| Emergency overload | :130°C |
| Short circuit      | :250°C |

### **3.12 SHORT CIRCUIT RATING:**

All cables shall be capable of withstanding without damage or permanent distortion the specified maximum short circuit currents for the specified times as under: -

The temperature of the conductors during the passage of the specified maximum fault current for the specified time of one second shall not exceed 250° C for XLPE cables.

The cable design including the design of external Clamps or other restraining devices shall be adequate to contain the mechanical forces arising from two or three phase short circuit currents and longitudinal forces whether arising from magnetic effects or from thermal expansion of conductors.

The cable is suitable in all respect for use on an 11 KV system with a nominal 3-phase fault level described in table-2.

The cable metallic screen sheath and armor shall be capable of passing the specified maximum earth fault current for the specified time of one second without damage, permanent distortion or deterioration in the cable where the cable must have the short circuit capability of it's metallic screen as per table-2.

## **4.0 TESTS:**

### **4.1 GENERAL**

The following tests shall be carried out to demonstrate the integrity of the cable. The frequency of the alternating current supply is between 48 Hz and 62 Hz.

### **4.2 TESTS AT MANUFACTURER'S WORKS**

Tests shall be carried out in accordance with the relevant IEC publication and the following type tests and routine tests shall be carried out at the Manufacturer's works.

#### **c) TYPE TESTS**

Type test for 15 KV cables shall be carried out in accordance with the IEC publication 60502 for suitable length of cable.

##### **ii) ELECTRICAL TESTS**

1. Partial Discharge test (s).
2. Bending test.
3. Heat cycle test.
4. Impulse Voltage withstand test
5. High voltage Alternating current test

##### **II) NON-ELECTRICAL TEST**

1. Measurement of Insulation thickness
2. Measurement of thickness of non-metallic sheath.
3. Determination of mechanical properties of insulation and sheaths before and after aging.
4. Ageing test on pieces of complete cables.
5. Pressure test at high temperature on insulation & sheaths.
6. Hot set test.
7. Water absorption test on insulations.

8. Shrinkage test on XLPE insulation.
9. Electrical test after installation.
10. Water penetration test.

**d) ROUTINE TESTS:**

The manufacturer shall carry out routine tests on all finished cables to demonstrate their individual integrity as per IEC pub. 60502.

1. Measurement of Electrical Resistance of conductors.
2. High voltage test
3. Partial discharge test

### **4.3 SPECIAL TEST**

Additional samples of cable shall be selected for special tests. The number and frequency of special tests shall be in accordance with the procedures specified in IEC publication 60502.

The cable shall be subjected to the following special tests.

1. Conductor examination
2. Check of dimensions
3. Electrical test for cables
4. Hot set test.

## **5. PACKING**

Cable shall be shipped on standard non-returnable steel drum, each drum having stenciled on its side; Size, Type, and length of cable, gross & net weight and contract number. The complete cable drum shall be covered by steel sheet to protect from external thrust and the kits are to be export-packed and properly protected for shipment, rough transportation and storage.

The maximum length of cable on a drum shall be **as per table-2** with a variation of + / - 10 % (ten percent) and it shall be only one length of conductor on a reel.

Each kits cartoon shall be sealed in water proof polyethylene bag having a silica gel packet placed inside the unit and then packed in polystyrene foam gasket closed by self-adhesive tape. Size of the items shall be marked by label on the foam for easy identification. Maximum 10 (ten) sets kits are allowed to pack into separate wooden packing box lined with heavy gauge polyethylene.

## **6. DOCUMENTATION**

The following test reports and the attached data schedule filled in completely shall be included with offer, without which the offer shall not be considered for evaluation.

- b) All Routine Test, Type Test and Special Test reports as per clause 4.2a, 4.2b, 4.3 of the specification and ISO-9001 Certificate of the identical offer type 15KV cables from an internationally recognized independent laboratory.

- c) Printed catalogue/Leaflet for the offered type of cables.

## **7. DRAWINGS & APPROVAL PROCEDURE**

- a) Within 30 days of contract commencement the Supplier shall submit, for approval by the Purchaser, a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a program of drawing submission, for approval by the Purchaser that ensures that all drawings and calculations are submitted within the period specified above.
- b) The Supplier shall submit all drawings, documents and type test reports for approval in sufficient time to permit modifications to be made if such are deemed necessary and resubmit them for approval without delaying the initial deliveries or completion of the contract work. If the Purchaser is satisfied with the drawing, one copy will be turned to the Supplier marked with "Approved" stamp. If the Purchaser is partially satisfied with the drawing, then Approved Subject to Comment" status will be given to it and a comment sheet will be sent to the Supplier. If the drawing submitted does not comply with the requirements of the specification, then it will be given "Not Approved" status and a comment sheet will be sent to the Supplier. In both these cases the Supplier will have to modify the drawing, update the revision column and resubmit for final Approval.

**Table-2**

| Item No. | Conductor                                      |                                          | XLPE Insulation Thickness (mm) | Max <sup>m</sup> D. C Resistance of Conductor at 20°C ( $\Omega/\text{km}$ ) | Short Circuit Withstand Capacity For 1 Second(min) |                          | Stand. Packing Length (m) (will be finalize during drawing approval) |
|----------|------------------------------------------------|------------------------------------------|--------------------------------|------------------------------------------------------------------------------|----------------------------------------------------|--------------------------|----------------------------------------------------------------------|
|          | Nominal Cross Sectional Area ( $\text{mm}^2$ ) | Minimum number of wires in the conductor |                                |                                                                              | Phase conductor (KA)                               | Metallic Screen for (KA) |                                                                      |
| F-1      | 95                                             | 15                                       | 4.50                           | 0.193                                                                        | 12.5                                               | 3                        | 375-800                                                              |
| F-2      | 120                                            | 18                                       | 4.50                           | 0.153                                                                        | 17                                                 | 4                        | 350-800                                                              |
| F-3      | 150                                            | 18                                       | 4.50                           | 0.124                                                                        | 20                                                 | 5                        | 300-800                                                              |
| F-4      | 185                                            | 30                                       | 4.50                           | 0.0991                                                                       | 25                                                 | 6                        | 300-800                                                              |

## 7. GENERAL REQUIREMENT OF 11 KV XLPE UNDERGROUND CABLE

| SL. No. | Particulars                       | BREB Required                                        |
|---------|-----------------------------------|------------------------------------------------------|
| 1.      | INSTALLATION                      | Direct burial                                        |
| 2.      | TYPE                              | XLPE insulated, 3-core, armoured, underground cable. |
| 3.      | VOLTAGE:                          |                                                      |
|         | a. Voltage between phases         | 11 KV                                                |
|         | b. Maximum system voltage         | 15 KV                                                |
|         | c. Rated voltage of cable $U_0/U$ | 8.7/15 KV                                            |
| 4.      | CORES:                            |                                                      |
|         | Number of cores                   | Three core, stranded copper, round concentric.       |
| 5.      | CONDUCTOR:                        |                                                      |

|    |                                                            |                                                  |
|----|------------------------------------------------------------|--------------------------------------------------|
|    | a. Material                                                | copper                                           |
|    | b. Design (stranded sectional etc.)                        | round, compacted                                 |
|    | c. Strand                                                  | As per table-2                                   |
|    | d. Cross sectional area of each conductor core             | As per table-2 or specified in material schedule |
|    | e. Maximum DC resistance of conductor at 20 <sup>0</sup> C | As per table-2                                   |
| 6. | CONDUCTOR SCREEN:                                          |                                                  |
|    | a. Material                                                | Extruded Semi-conducting PE                      |
| 7. | INSULATION:                                                |                                                  |
|    | a. Thickness (Nom)                                         | 4.50 mm                                          |
|    | b. Type of curing                                          | Dry curing                                       |
| 8. | INSULATION SHIELD                                          | Extruded Semi-conducting PE                      |



| SL. No. | Particulars                        | BREB Required                                                                                                                             |
|---------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 9.      | METAL SHIELD                       | Copper wire                                                                                                                               |
| 10.     | INNER SHEATH                       | Polyvinyl Chloride (PVC)                                                                                                                  |
| 11.     | ARMOUR                             | Aluminum Alloy Wire.                                                                                                                      |
| 12.     | OUTER SHEATH                       | Medium Density Polyethylene (MDPE)                                                                                                        |
| 13.     | Short Circuit Withstand Capability | As per table-2                                                                                                                            |
| 14.     | STANDARDS                          | Design, Manufacture, Testing & Performance shall be in accordance to latest revision of IEC-60502-2 or Equivalent International standard. |

## 8. TECHNICAL SPECIFICATION OF JOINTING KITS FOR 11 KV XLPE, 3-CORE, COPPER CABLE

### 8.1. TERMINATION KITS (OUTDOOR)

| Sl. No. | Name of Item         | Termination jointing kits for 15 KV XLPE cable 3-core, (Outdoor)                                                                                                                                                                               |
|---------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | Application          | For 11 KV, 3- core, XLPE, copper conductor armored cable                                                                                                                                                                                       |
| 2.      | Installation         | Outdoor, mounted on Poles/Structure                                                                                                                                                                                                            |
| 3.      | Country of origin    | <b>USA/UK/Germany/Switzerland/France/Japan/EU/Australia/</b> Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |
| 4.      | Place of Manufacture |                                                                                                                                                                                                                                                |
| 5.      | System               | 11 KV, effectively grounded system                                                                                                                                                                                                             |
| 6.      | Cable Conductor      | 185 mm <sup>2</sup> copper conductor                                                                                                                                                                                                           |
| 7.      | Kit content          | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                                                                                                                |
|         |                      | Heat shrinkable stress control tubing                                                                                                                                                                                                          |
|         |                      | Stress relieving mastic strip                                                                                                                                                                                                                  |
|         |                      | Truck resistant sealant tape                                                                                                                                                                                                                   |
|         |                      | Heat shrinkable track resistant rain skirt                                                                                                                                                                                                     |
|         |                      | Support Insulator                                                                                                                                                                                                                              |
|         |                      | Cable preparation kit                                                                                                                                                                                                                          |
|         |                      | Solderless earth connection kit                                                                                                                                                                                                                |
|         |                      | Compression lugs                                                                                                                                                                                                                               |
|         |                      | Support Insulators Tee brackets                                                                                                                                                                                                                |
|         |                      | Installation Instructions                                                                                                                                                                                                                      |

### 8.2 TERMINATION KITS (INDOOR)

| Sl. No. | Name of Item | Termination jointing kits for 15 KV XLPE cable 3-core (Indoor) |
|---------|--------------|----------------------------------------------------------------|
| 1.      | Application  | For 11 KV, 3- core, XLPE, copper conductor armored             |



|    |                      |                                                                                                                                                                                                                                                |
|----|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2. | Installation         | For indoor switchgear terminations                                                                                                                                                                                                             |
| 3. | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia/<br>Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated<br>(Acceptance of equivalency will depend on Employer). |
| 4. | Place of Manufacture |                                                                                                                                                                                                                                                |
| 5. | System               | 11 KV, effectively grounded system                                                                                                                                                                                                             |
| 6. | Cable Conductor      | 185 mm <sup>2</sup> copper conductor                                                                                                                                                                                                           |
| 7. | Kit content          | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                                                                                                                |
|    |                      | Heat shrinkable stress control tubing                                                                                                                                                                                                          |
|    |                      | Stress relieving mastic strip                                                                                                                                                                                                                  |
|    |                      | Truck resistant sealant tape                                                                                                                                                                                                                   |
|    |                      | Heat shrinkable track resistant rain skirt                                                                                                                                                                                                     |
|    |                      | Cable preparation kit                                                                                                                                                                                                                          |
|    |                      | Solderless earth connection kit                                                                                                                                                                                                                |
|    |                      | Compression lugs                                                                                                                                                                                                                               |
|    |                      | Installation Instructions                                                                                                                                                                                                                      |

### 8.3 STRAIGHT THROUGH JOINT BOX

|         |                      |                                                                                                                                                                                                                                         |
|---------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sl. No. | Name of Item         | Straight through joint box for 15 KV XLPE cable, 3-core copper conductor.                                                                                                                                                               |
| 1.      | Application          | For 11 KV, 3- core, XLPE, copper conductor armored cable                                                                                                                                                                                |
| 2.      | Installation         | For underground horizontal mounting                                                                                                                                                                                                     |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |
| 4.      | Place of Manufacture |                                                                                                                                                                                                                                         |
| 5.      | System               | 11 KV, effectively grounded system                                                                                                                                                                                                      |
| 6.      | Cable Conductor      | 185 mm <sup>2</sup> copper conductor                                                                                                                                                                                                    |
| 7.      | Construction         | The joint shall be proof against ingress of moisture and water.                                                                                                                                                                         |
| 8.      | Kit content          | Compression ferrules                                                                                                                                                                                                                    |
|         |                      | Valid filling tape                                                                                                                                                                                                                      |
|         |                      | Heat shrinkable stress control tubing                                                                                                                                                                                                   |
|         |                      | Truck resistant sealant tape                                                                                                                                                                                                            |
|         |                      | Heat shrinkable high voltage insulating tape                                                                                                                                                                                            |
|         |                      | Heat shrinkable black/red dual wall                                                                                                                                                                                                     |
|         |                      | Estomeric tube                                                                                                                                                                                                                          |
|         |                      | Roll spring                                                                                                                                                                                                                             |
|         |                      | Heat shrinkable outer jacket tube                                                                                                                                                                                                       |
|         |                      | Heat shrinkable truck resistant rain skirt.                                                                                                                                                                                             |
|         |                      | Cable preparation kit                                                                                                                                                                                                                   |
|         |                      | Solder less earth connection kit                                                                                                                                                                                                        |
|         |                      | Misc. other material                                                                                                                                                                                                                    |
|         |                      | Installation instructions                                                                                                                                                                                                               |

**Note-1:** The size & quantity of the termination kits and straight through joint splices shall be as per material & price schedule.



**Note-2:** A team of 03 technical personnel of BREB will visit for 03 days at manufacturer's premises / factory during manufacturing of 11 kV, 3cx185mm<sup>2</sup> XLPE (Cu) Cable and inspect the procedure of manufacturing & also inspect the item as per the required standard. The Contractor will be responsible for arranging & bearing all costs for the team including visa fees, air fares, accommodation, fooding, laundry, transportation etc. plus a daily allowance (not less than GOB standard) for each member of the team.

### TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE

FOR 15 KV 11 KV XLPE, 3-CORE, 185 MM2 COPPER CABLE

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| SI No. | Technical Particulars                          | REB Specification                                    | Guaranteed Specification |
|--------|------------------------------------------------|------------------------------------------------------|--------------------------|
| 1      | Manufacturer & Cat. No.                        | To be mentioned                                      |                          |
| 2      | INSTALLATION                                   | Direct burial                                        |                          |
| 3      | TYPE                                           | XLPE insulated, 3-core, armoured, underground cable. |                          |
| 4      | VOLTAGE:                                       |                                                      |                          |
|        | a. Voltage between phases                      | 11 KV                                                |                          |
|        | b. Maximum system voltage                      | 15 KV                                                |                          |
|        | c. Rated voltage of cable U <sub>0</sub> /U    | 8.7/15 KV                                            |                          |
| 5      | CORES:                                         |                                                      |                          |
|        | Number of cores                                | Three core, stranded copper, round concentric.       |                          |
| 6      | CONDUCTOR:                                     |                                                      |                          |
|        | a. Material                                    | Copper                                               |                          |
|        | b. Design (stranded sectional etc.)            | Round, compacted                                     |                          |
|        | c. Strand                                      | As per table-2                                       |                          |
|        | d. Cross sectional area of each conductor core | As per table-2 or specified in material schedule     |                          |
|        | e. Maximum DC resistance of conductor at 200 C | As per table-2                                       |                          |
| 7      | CONDUCTOR SCREEN:                              |                                                      |                          |
|        | a. Material                                    | Extruded Semi-conducting PE                          |                          |
| 8      | INSULATION:                                    |                                                      |                          |
|        | a. Thickness (Nom)                             | 4.50 mm                                              |                          |
|        | b. Type of curing                              | Dry curing                                           |                          |
| 9      | INSULATION SHIELD                              | Extruded Semi-conducting PE                          |                          |
| 10     | METAL SHIELD                                   | Copper wire                                          |                          |
| 11     | INET SHEATH                                    | Polyvinyl Chloride (PVC)                             |                          |
| 12     | ARMOUR                                         | Aluminum Alloy Wire.                                 |                          |
| 13     | OUTER SHEATH                                   | Medium Density Polyethylene (MDPE)                   |                          |
| 14     | Short Circuit Withstand Capability             | As per table-2                                       |                          |

|    |           |                                                                                                                                           |  |
|----|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|--|
| 15 | STANDARDS | Design, Manufacture, Testing & Performance shall be in accordance to latest revision of IEC-60502-2 or Equivalent International standard. |  |
|----|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|--|

**Seal & Signature of the Bidder**

**Seal & Signature of the manufacturer**

## **8.2 TERMINATION KITS (INDOOR)**



**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****FOR TERMINATION JOINTING KITS FOR 15 KV XLPE, 3-CORE, 185 MM2 COPPER CABLE  
(OUTDOOR)**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| <b>Sl. No</b> | <b>Technical Particulars</b> | <b>REB Specification</b>                                                                                                                          | <b>Guaranteed Specification</b> |
|---------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 1             | Manufacturer & Cat. No.      | To be mentioned                                                                                                                                   |                                 |
| 2             | Application                  | For 11 KV, 3- core, XLPE, copper conductor armored cable                                                                                          |                                 |
| 3             | Installation                 | Outdoor, mounted on Poles/Structure                                                                                                               |                                 |
| 4             | Country of origin            | USA/UK/German/Switzerland/France/ Japan/EU/Australia/ Other eligible countries may be                                                             |                                 |
| 5             | Place of Manufacture         | accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |                                 |
| 6             | System                       | 11 KV, effectively grounded system                                                                                                                |                                 |
| 7             | Cable Conductor              | 185 mm <sup>2</sup> copper conductor                                                                                                              |                                 |
| 8             | Kit content                  | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                   |                                 |
|               |                              | Heat shrinkable stress control tubing                                                                                                             |                                 |
|               |                              | Stress relieving mastic strip                                                                                                                     |                                 |
|               |                              | Truck resistant sealant tape                                                                                                                      |                                 |
|               |                              | Heat shrinkable track resistant rain skirt                                                                                                        |                                 |
|               |                              | Support Insulator                                                                                                                                 |                                 |
|               |                              | Cable preparation kit                                                                                                                             |                                 |
|               |                              | Solderless earth connection kit                                                                                                                   |                                 |
|               |                              | Compression lugs                                                                                                                                  |                                 |
|               |                              | Support Insulators Tee brackets                                                                                                                   |                                 |
|               |                              | Installation Instructions                                                                                                                         |                                 |

**Seal & Signature of the**

**Seal & Signature of the**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****FOR TERMINATION JOINTING KITS FOR 15 KV XLPE, 3-CORE, 185 MM<sup>2</sup> COPPER CABLE  
(INDOOR)**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| <b>SI No</b> | <b>Technical Particulars</b> | <b>REB Specification</b>                                                                                                                                                                                                                 | <b>Guaranteed Specification</b> |
|--------------|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 1            | Manufacturer & Cat. No.      | To be mentioned                                                                                                                                                                                                                          |                                 |
| 2            | Application                  | For 11 KV, 3- core, XLPE, copper conductor armored cable                                                                                                                                                                                 |                                 |
| 3            | Installation                 | For indoor switchgear terminations                                                                                                                                                                                                       |                                 |
| 4            | Country of origin            | USA/UK/Germany/Switzerland/France/Japan/ EU/Australia/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |                                 |
| 5            | Place of Manufacture         |                                                                                                                                                                                                                                          |                                 |
| 6            | System                       | 11 KV, effectively grounded system                                                                                                                                                                                                       |                                 |
| 7            | Cable Conductor              | 185 mm <sup>2</sup> copper conductor                                                                                                                                                                                                     |                                 |
| 8            | Kit content                  | Heat shrinkable high voltage insulating and non-tracking tubing                                                                                                                                                                          |                                 |
|              |                              | Heat shrinkable stress control tubing                                                                                                                                                                                                    |                                 |
|              |                              | Stress relieving mastic strip                                                                                                                                                                                                            |                                 |
|              |                              | Truck resistant sealant tape                                                                                                                                                                                                             |                                 |
|              |                              | Heat shrinkable track resistant rain skirt                                                                                                                                                                                               |                                 |
|              |                              | Cable preparation kit                                                                                                                                                                                                                    |                                 |
|              |                              | Solderless earth connection kit                                                                                                                                                                                                          |                                 |
|              |                              | Compression lugs                                                                                                                                                                                                                         |                                 |
|              |                              | Installation Instructions                                                                                                                                                                                                                |                                 |

**Seal & Signature of the Bidder****Seal & Signature of the manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

FOR STRAIGHT THROUGH JOINT BOX FOR 15 KV XLPE, 3-CORE, 185 MM2 COPPER CABLE

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Sl. No. | Technical Particulars   | REB Specification                                                                                                                                        | Guaranteed Specification |
|---------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1       | Manufacturer & Cat. No. | To be mentioned                                                                                                                                          |                          |
| 2       | Application             | For 11 KV, 3- core, XLPE, copper conductor armored cable                                                                                                 |                          |
| 3       | Installation            | For underground horizontal mounting                                                                                                                      |                          |
| 4       | Country of origin       | USA/UK/Germany/Switzerland/France/Japan/E U/Australia/ Other eligible countries                                                                          |                          |
| 5       | Place of Manufacture    | may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer). |                          |
| 6       | System                  | 11 KV, effectively grounded system                                                                                                                       |                          |
| 7       | Cable Conductor         | 185 mm <sup>2</sup> copper conductor                                                                                                                     |                          |
| 8       | Cable Conductor         | The joint shall be proof against ingress of moisture and water.                                                                                          |                          |
| 9       | Kit content             | Compression ferrules                                                                                                                                     |                          |
|         |                         | Valid filling tape                                                                                                                                       |                          |
|         |                         | Heat shrinkable stress control tubing                                                                                                                    |                          |
|         |                         | Truck resistant sealant tape                                                                                                                             |                          |
|         |                         | Heat shrinkable high voltage insulating tape                                                                                                             |                          |
|         |                         | Heat shrinkable black/red dual wall                                                                                                                      |                          |
|         |                         | Estomeric tube                                                                                                                                           |                          |
|         |                         | Roll spring                                                                                                                                              |                          |
|         |                         | Heat shrinkable outer jacket tube                                                                                                                        |                          |
|         |                         | Heat shrinkable truck resistant rain skirt.                                                                                                              |                          |
|         |                         | Cable preparation kit                                                                                                                                    |                          |
|         |                         | Solder less earth connection kit                                                                                                                         |                          |
|         |                         | Misc. other material                                                                                                                                     |                          |
|         |                         | Installation instructions                                                                                                                                |                          |

**Seal & Signature of the Bidder****Seal & Signature of the manufacturer**

Note: If any data deviate in the GTP with the detail specification, then specification will prevail.





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**REB ITEM NO.: F-11 through F-14**

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PUBLICATION 268-2026  
RURAL ELECTRIFICATION BOARD (REB)  
PEOPLES REPUBLIC OF BANGLADESH  
STANDARD FOR  
15 KV 1-CORE UNDERGROUND POWER CABLE

**1. GENERAL**

This standard establishes the physical and electrical requirements for 15 KV, 1-Core, copper conductor, cross-linked polyethylene (XLPE) insulated power cable shall comply with IEC-60502. The cable shall be suitable in all respect for use in 11 KV system, 50 hertz, underground distribution system.

**2. REFERENCE DATA:**

REB 15 KV, 1- core underground cable shall be comprised of the following:

**2.1 CONDUCTOR.**

The conductor shall be stranded, circular and compacted copper wire in accordance with IEC-228 or ASTM B3.

**2.2 CONDUCTOR SCREEN**

The conductor screen shall comprise of a layer of extruded semi-conducting compound, compatible in all respects with the conductor and insulation material. Conductor screen shall be bonded to the insulation such a way that no voids or discontinuities are present. The bond shall be adequate to withstand normal electrical and mechanical stresses in service without degradation or separation.

Lapped semi-conducting tape shall not be used for conductor screens.

**2.3 INSULATION**

The insulation shall be cross-linked polyethylene (XLPE). The cable insulation shall be extruded in one operation with conductor & insulation screens. The highest possible purity of insulation material is required. The Bidder shall demonstrate that adequate precautions are taken to remove contaminants and to eliminate the introduction of particles of contaminate during material handling or the extrusion process.

The insulation material shall consist of cross-linked polyethylene tightly extruded over the conductor screen. A cross-linking process using steam curing will not be permitted. Dry process using the Catenary Continuous Vulcanization or the Vertical Continuous Vulcanization insulation shall be offered, without which the tender will not considered.

**2.4 INSULATION THICKNESS**

The insulation thickness of the cables shall not be less than the values tabulated in IEC publication 60502. Insulation thickness shall not depart from the specified nominal value by an amount exceeding the tolerance specified in IEC publication-60502.

The thickness of the semi conducting screens on the conductors and over the insulation shall not be included in the measurement of insulation thickness.

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**REB ITEM NO.: F-11 through F-14**

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**2.5 INSULATION SCREEN**

The insulation screen shall comprise of a non-metallic semi-conducting polyethylene part in combination with a metallic part.

The non-metallic semi-conducting part shall be applied directly upon the insulation of each core and shall comprise of a layer of extruded semi-conducting polyethylene compound.

The conductor screen, Insulation and semi-conducting part of Insulation screen layer shall be applied to the conductor in common extrusion process with dry curing system.

The metallic part shall be stranded copper applied directly over the semi-conducting part. It shall comprise of a single layer of copper wires equally spaced apart.

**2.6 ARMOUR**

The armour shall consist of a single layer of non-magnetic wires (aluminum alloy wire) in accordance with IEC-60502. The armour wires shall cover the whole diameter of the cable.

The non-magnetic wire joints are brazed or welded and any wire shall be not less than 1 mm from nearest joints in any other armour wire in the complete cable.

**2.7 OVER SHEATH**

The cable shall be sheathed overall with a MDPE (medium density polyethylene) outer sheath. The outer sheath shall be of smooth and uniform composition and free of holes. Cracks blisters and imperfection. The external jacket shall be loaded with 2.5% carbon black for UV resistance.

As a protection against termite attack, the outer covering shall contain termite repellent substance of Pb nephtanate.

The outer sheath shall be of adequate strength and thickness to withstand the test voltages and mechanical tests and shall be suitable for the ambient conditions at site.

The outer sheath material shall be capable of withstanding without damage or deformation the highest temperature achieved with the cable at its rated current and at the site ambient conditions.

**2.8 MANUFACTURER'S IDENTIFICATION.**

The manufacturer's identification shall be printed with white color on the identifying tape. It shall show the rated voltage, conductor size, year of manufacturing and name of the manufacturer at an interval of not more than 1000 mm throughout the length of the cable. The designation of voltage and cable marking shall also be embossed on the outer MDPE covering. The gap between the end of one set of embossed characters and the beginning of the next shall be not greater than 150 mm throughout the length of cable with character approximately 10 mm high.

Name of the purchaser shall be embossed in the title- RURAL ELECTRIFICATION BOARD at every 1000 mm gap.

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**REB ITEM NO.: F-11 through F-14**

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**2.9 CONTINUOUS CURRENT RATING :**

The continuous rating of the cables that the bidder proposes to supply shall be calculated by means of the procedure described in IEC publication 287 based on the site ambient conditions including solar radiation, with the installation parameters as specified.

The maximum conductor temperature shall not exceed 90° C when carrying the rated current under the most onerous site conditions.

The bidder shall base his ratings on the site ambient conditions, with the methods of installation and bonding as specified. Due account shall be taken of the heating due to other cables or other sources of heat where these can be identified. The bidder shall state all the parameters including any assumptions that he has made in the calculation of continuous current ratings.

**2.10 SHORT CIRCUIT RATING:**

All cables shall be capable of with standing without damage or permanent distortion the specified maximum short circuit currents for the specified times as under: -

The temperature of the conductors during the passage of the specified maximum fault current for the specified time of one second shall not exceed 250° C for XLPE cables.

The cable design including the design of external Clamps or other restraining devices shall be adequate to contain the mechanical forces arising from two or three phase short circuit currents and longitudinal forces whether arising from magnetic effects or from thermal expansion of conductors.

The cable metallic screen sheath and armor shall be capable of passing earth fault current for the specified time of one second without damage, permanent distortion or deterioration in the cable. The metallic screen shall be capable of carrying an earth fault current without damage as per table-2 of the specification.

If in order to comply with the requirement for carrying prospective earth fault current it is necessary to rely on the armor and/ or sheath conductivity in addition to metallic core screen tapes, the bedding material or materials shall be of the semi-conducting type.

**3. TESTS:****3.1 GENERAL**

The following tests shall be carried out to demonstrate the integrity of the cable. The frequency of the alternating current supply is between 48 Hz and 62 Hz.

Tests shall be carried out in accordance with the relevant IEC standard at the Manufacturer's works, except that Type tests shall be conducted at an internationally recognized third party testing laboratory. The result of type tests report on same offered cable or similar type same voltage class of higher size or similar type higher voltage class of same/higher size of underground cables, as defined in IEC 60502.

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**REB ITEM NO.: F-11 through F-14**

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**3.2 TESTS AT MANUFACTURER'S WORKS**

Tests shall be carried out in accordance with the relevant British standards IEC publication and the following type tests and routine tests shall be carried out at the Manufacturer's works.

**a) TYPE TESTS**

Type test for 15 KV cables shall be carried out in accordance with the IEC publication 540 and 60502 for suitable length of cable.

**i) ELECTRICAL TESTS**

1. Partial Discharge test (s).
2. Bending test.
3. Heat cycle test.
4. Impulse Voltage withstand test
5. High voltage Alternating current test

**II) NON-ELECTRICAL TEST**

1. Measurement of Insulation thickness
2. Measurement of thickness of non-metallic sheath.
3. Determination of mechanical properties of insulation and sheaths before and after aging.
4. Ageing test on pieces of complete cables.
5. Pressure test at high temperature on insulation & sheaths.
6. Hot set test.
7. Water absorption test on insulations.
8. Shrinkage test on XLPE insulation.
9. Electrical test after installation.

**b) ROUTINE TESTS:**

The manufacturer shall carry out routine tests on all finished cables to demonstrate their individual integrity as per IEC pub. 60502

1. Measurement of Electrical Resistance of conductors.
2. High voltage test
3. Partial discharge test

**3.3 SPECIAL TEST**

Additional samples of cable shall be selected for special tests. The number and frequency of special tests shall be in accordance with the procedures specified in IEC publication 60502.

The cable shall be subjected to the following special tests.

1. Conductor examination
2. Check of dimensions
3. Electrical test for cables
4. Hot set test.

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**REB ITEM NO.: F-11 through F-14**

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**4. PACKING**

Cable shall be shipped on standard non-returnable steel drum, each drum having stenciled on its side; Size, Type, and length of cable, gross & net weight and contract number. The complete cable drum shall be covered by steel sheet to protect from external thrust and the kits are to be export-packed and properly protected for shipment, rough transportation and storage.

The maximum length of cable on a drum shall be 500-1500 meters with a variation of + / - 10 %(ten percent) which should be finalized during drawing approval and it shall be only one length of conductor on a reel.

Each kits cartoon shall be sealed in water proof polyethylene bag having a silica gel packet placed inside the unit and then packed in polystyrene foam gasket closed by self adhesive tape. Size of the items shall be marked by label on the foam for easy identification. Maximum 10 (ten) sets kits are allowed to pack into separate wooden packing box lined with heavy gauge polyethylene.

**5. DOCUMENTATION**

The following test reports and the attached data schedule filled in completely shall be included with offer, without which the offer shall not be considered for evaluation.

- a) All Routine Test, Type Test and Special Test reports as per clause 3.2a, 3.2b & 3.3 of the specification and ISO-9001 Certificate of the identical 15 KV cables from an internationally recognized independent laboratory.
- b) Supply record with documentary evidence of the submitted type tested cables for last 5 (five) years mentioning purchaser's name, quantity, and year of supply.
- c) Design/ drawing of offered cable with short circuit calculation.
- d) Printed catalogue/Leaflet for the offered type of cables.

**REB ITEM NO.: F-11 through F-14****6. GENERAL REQUIREMENT OF 11 KV XLPE UNDERGROUND CABLE****Table-1**

| SL. No. | Particulars                                    | Specified                                                                                                                                    |
|---------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | Installation                                   | Direct burial                                                                                                                                |
| 2.      | Type                                           | XLPE insulated, 1-core, armoured, under ground cable.                                                                                        |
| 3.      | Voltage:                                       |                                                                                                                                              |
|         | a. Voltage between phases                      | 11 KV                                                                                                                                        |
|         | b. Maximum system voltage                      | 15 KV                                                                                                                                        |
| 4.      | CORES:                                         |                                                                                                                                              |
|         | Number of cores                                | Single core, stranded copper, round concentric.                                                                                              |
| 5.      | CONDUCTOR:                                     |                                                                                                                                              |
|         | a. Material                                    | copper                                                                                                                                       |
|         | b. Design (stranded sectional etc.)            | round, compacted                                                                                                                             |
|         | c. Strand                                      | As per table-2                                                                                                                               |
|         | d. Cross sectional area of conductor core      | As per table-2 or specified as per material & price schedule                                                                                 |
|         | e. Maximum DC resistance of conductor at 20° C | As per table-2                                                                                                                               |
| 6.      | CONDUCTOR SCREEN:                              |                                                                                                                                              |
|         | a. Material                                    | Extruded Semi-conducting PE                                                                                                                  |
| 7.      | INSULATION:                                    |                                                                                                                                              |
|         | a. Thickness (Nom)                             | 4.50 mm                                                                                                                                      |
|         | b. Type of curing                              | Dry curing                                                                                                                                   |
| 8.      | INSULATION SHIELD                              | Extruded Semi-conducting PE                                                                                                                  |
| 9.      | ARMOUR:                                        | A single layer of non-magnetic wire (aluminum alloy wire) in accordance with IEC 60502.                                                      |
| 10.     | OVER SHEATH                                    | Medium Density Polyethylene (MDPE)                                                                                                           |
| 11.     | STANDARDS                                      | Design, Manufacture, Testing & Performance shall be in accordance to latest revision of IEC-60502, 540 or Equivalent International Standard. |

**Table-2**

| Item No. | Conductor           |                                | Max D.C. Resistance at 20°C (Ω/km) | Nominal XLPE Insulation Thickness (mm) | Short-Circuit Withstand Capacity for 1 Second (minimum) |                      |                 |
|----------|---------------------|--------------------------------|------------------------------------|----------------------------------------|---------------------------------------------------------|----------------------|-----------------|
|          | Cross-Section (mm²) | Minimum wires in the conductor |                                    |                                        | Phase Conductor (kA)                                    | Metallic Screen (kA) | Armor Wire (kA) |
| F-11     | 240                 | 34                             | 0.0754                             | 4.5                                    | 34                                                      | 12                   | 15              |
| F-12     | 300                 | 34                             | 0.0601                             | 4.5                                    | 43                                                      | 15                   | 20              |
| F-13     | 400                 | 53                             | 0.0470                             | 4.5                                    | 57                                                      | 20                   | 25              |
| F-14     | 500                 | 53                             | 0.0366                             | 4.5                                    | 71                                                      | 25                   | 32              |

**REB ITEM NO.: F-11 through F-14****7. TECHNICAL SPECIFICATION OF JOINTING KITS FOR 15 KV XLPE,1-CORE, COPPER CABLE****7.1. TERMINATION KITS ( OUTDOOR)**

| Sl. No. | Name of Item         | Termination jointing kits for 15 KV XLPE cable single-core, (Outdoor) |
|---------|----------------------|-----------------------------------------------------------------------|
| 1.      | Application          | For 11 KV, 1 core, XLPE, copper conductor armored cable               |
| 2.      | Installation         | Outdoor, mounted on Poles/Structure                                   |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                  |
| 4.      | Place of Manufacture | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                  |
| 5.      | System               | 11 KV, effectively grounded system                                    |
| 6.      | Cable Conductor      | As per Table-2 & material & price schedule.                           |
| 7.      | Kit content          | Heat shrinkable high voltage insulating and non-tracking tubing       |
|         |                      | Heat shrinkable stress control tubing                                 |
|         |                      | Stress relieving mastic strip                                         |
|         |                      | Truck resistant sealant tape                                          |
|         |                      | Heat shrinkable track resistant rain skirt                            |
|         |                      | Support Insulator                                                     |
|         |                      | Cable preparation kit                                                 |
|         |                      | Solderless earth connection kit                                       |
|         |                      | Compression lugs                                                      |
|         |                      | Support Insulators Tee brackets                                       |
|         |                      | Installation Instructions                                             |

**7.2 TERMINATION KITS ( INDOOR)**

| Sl. No. | Name of Item         | Termination jointing kits for 15 KV XLPE cable single-core (Indoor) |
|---------|----------------------|---------------------------------------------------------------------|
| 1.      | Application          | For 11 KV, 1 core, XLPE, copper conductor armored cable             |
| 2.      | Installation         | For indoor switchgear terminations                                  |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                |
| 4.      | Place of Manufacture | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                |
| 5.      | System               | 11 KV, effectively grounded system                                  |
| 6.      | Cable Conductor      | As per Table-2 & material & price schedule.                         |
| 7.      | Kit content          | Heat shrinkable high voltage insulating and non-tracking tubing     |
|         |                      | Heat shrinkable stress control tubing                               |
|         |                      | Stress relieving mastic strip                                       |
|         |                      | Truck resistant sealant tape                                        |
|         |                      | Heat shrinkable track resistant rain skirt                          |
|         |                      | Cable preparation kit                                               |
|         |                      | Solderless earth connection kit                                     |
|         |                      | Compression lugs                                                    |
|         |                      | Installation Instructions                                           |



**REB ITEM NO.: F-11 through F-14****7.3 STRAIGHT THROUGH JOINT BOX**

|         |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sl. No. | Name of Item         | Straight through joint box for 15 KV XLPE cable, single-core copper conductor.                                                                                                                                                                                                                                                                                                                                                                    |
| 1.      | Application          | For 11 KV, 1 core, XLPE, copper conductor armored cable                                                                                                                                                                                                                                                                                                                                                                                           |
| 2.      | Installation         | For underground horizontal mounting                                                                                                                                                                                                                                                                                                                                                                                                               |
| 3.      | Country of origin    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                                                                                                                                                                                                                                                                                                                                                                                              |
| 4.      | Place of Manufacture | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                                                                                                                                                                                                                                                                                                                                                                                              |
| 5.      | System               | 11 KV, effectively grounded system                                                                                                                                                                                                                                                                                                                                                                                                                |
| 6.      | Cable Conductor      | As per Table-2 & material & price schedule.                                                                                                                                                                                                                                                                                                                                                                                                       |
| 7.      | Construction         | The joint shall be proof against ingress of moisture and water.                                                                                                                                                                                                                                                                                                                                                                                   |
| 8.      | Kit content          | Compression ferrules<br>Valid filling tape<br>Heat shrinkable stress control tubing<br>Truck resistant sealant tape<br>Heat shrinkable high voltage insulating tape<br>Heat shrinkable black/red dual wall<br>Estomeric tube<br>Roll spring<br>Heat shrinkable outer jacket tube<br>Heat shrinkable truck resistant rain skirt.<br>Cable preparation kit<br>Solder less earth connection kit<br>Misc. other material<br>Installation instructions |

**Note :** The size & quantity of the termination kits and straight through joint splices shall be as per material & price schedule.

| Section 6: Employer's Requirements                                                       |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 6-203                     |
|------------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Sl. No.                                                                                  | Description of Items                 | Required Particulars                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Manufacturers Particulars |
|                                                                                          |                                      | Conductors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                           |
| 4                                                                                        | Installation                         | For Outdoor installation on poles/structures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| 5                                                                                        | System                               | 11KV, effectively earthed system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                           |
| 6                                                                                        | Country of origin                    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                           |
| 7                                                                                        | Place of Manufacture                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 8                                                                                        | Cable conductor                      | 500 mm <sup>2</sup> 1-core Copper Conductors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| 9                                                                                        | Kit content                          | <ul style="list-style-type: none"> <li>- Heat shrinkable high voltage insulating and non-tracking tubing</li> <li>- Heat shrinkable stress control tubing</li> <li>- Stress relieving mastic strip</li> <li>- Truck resistant sealant tape</li> <li>- Heat shrinkable truck resistant rain skirt</li> <li>- Support insulator</li> <li>- Cable preparation kit</li> <li>- Solder less earth connection kit</li> <li>- Compression lugs for 500 mm<sup>2</sup> Copper Conductors</li> <li>- Support insulators Tee Brackets</li> <li>- Installation instruction</li> </ul> |                           |
| <b>Straight-through joint box for 11KV XLPE, 1-Core, 500 mm<sup>2</sup> Copper cable</b> |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 1                                                                                        | Name and address of the manufacturer | Shall be furnished                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                           |
| 2                                                                                        | Type/mod of the el kits              | Shall be furnished                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                           |
| 3                                                                                        | Application                          | For 11KV, 1-core, XLPE 500 mm <sup>2</sup> Copper Conductors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| 4                                                                                        | Installation                         | For underground horizontal mounting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                           |
| 5                                                                                        | System                               | 11KV, effectively earthed system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                           |
| 6                                                                                        | Country of origin                    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                           |
| 7                                                                                        | Place of Manufacture                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |

| <b>Sl. No.</b> | <b>Description of Items</b> | <b>Required Particulars</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Manufacturers Particulars</b> |
|----------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 8              | Cable conductor             | 500 mm <sup>2</sup> 1-core Copper Conductors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |
| 9              | Construction                | The joint shall be proof against ingress of moisture and water                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                  |
| 10             | Kit content                 | <ul style="list-style-type: none"> <li>- Compression ferrules</li> <li>- Valid filling tape</li> <li>- Heat shrinkable stress control tubing</li> <li>- Truck resistant sealant tape</li> <li>- Heat shrinkable high voltage insulating tape</li> <li>- Heat shrinkable black/red dual wall</li> <li>- Estomeric tube</li> <li>- Roll spring</li> <li>- Heat shrinkable outer jacket tube</li> <li>- Cable preparation kit</li> <li>- Solder less earth connection kit</li> <li>- Misc. other material</li> <li>- Installation instructions</li> </ul> |                                  |

**Seal & Signature of the Bidder  
manufacturer**

**Seal & Signature of the**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE****FOR 11KV, 1-CORE X 500 SQ. MM U/G XLPE COPPER CABLE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Sl. No. | Description of Items                                       | Unit   | Required Specification           | Supplier's / Manufacturer's Particulars |
|---------|------------------------------------------------------------|--------|----------------------------------|-----------------------------------------|
| 1       | Name & address of the Manufacturer                         |        | To be mentioned                  |                                         |
| 2       | Type/Model of the offered Cable                            |        | To be mentioned                  |                                         |
| 3       | System Voltage                                             | KV     | 11                               |                                         |
| 5       | Process of manufacturing                                   |        | VCV/CCV.                         |                                         |
| 6       | Number of core and Cross-sectional area of conductor cores | Sq.mm  | 1X500 mm <sup>2</sup>            |                                         |
| 7       | Conductor materials                                        |        | Copper                           |                                         |
| 8       | Shape of conductor                                         |        | Round                            |                                         |
| 9       | Type of conductor screen                                   |        | Semi-conducting                  |                                         |
| 10      | Thickness of semi-conducting screen                        | mm     | 0.6                              |                                         |
| 11      | Average thickness of insulation                            | mm     | 4.5                              |                                         |
| 12      | Process of curing                                          |        | Dry process                      |                                         |
| 13      | Material of Insulation                                     |        | Cross Linked Polyethylene (XLPE) |                                         |
| 14      | Type of non-metallic insulating screen                     |        | Semi-conducting                  |                                         |
| 15      | Thickness of semi-conducting insulation screen             | mm     | 1.0                              |                                         |
| 16      | Number and diameter of copper screen strands               | No./mm | Based on design calculation      |                                         |
| 17      | Composition of filler                                      |        | PVC                              |                                         |
| 18      | Composition of bedding                                     |        | Extruded PVC                     |                                         |
| 19      | Thickness of bedding                                       | mm     | Based on design calculation      |                                         |
| 20      | Number and diameter of armour wire                         | No./mm | As per IEC 60502                 |                                         |
| 21      | Average thickness of PVC over sheath                       | mm     | Based on design calculation      |                                         |
| 22      | Nominal diameter of complete cable                         | mm     | Based on design calculation      |                                         |

Section 6: Employer's Requirements

6-200

| Sl. No. | Description of Items                                                              | Unit   | Required Specification      | Supplier's / Manufacturer's Particulars |
|---------|-----------------------------------------------------------------------------------|--------|-----------------------------|-----------------------------------------|
| 23      | Nominal weight per meter of complete cable                                        | Kg/m   | Based on design calculation |                                         |
| 24      | Minimum radius of bend round which cable can be laid                              | mm     | Based on design calculation |                                         |
| 25      | Maximum D.C. resistance of conductor per meter at 20°C                            | Ohm/m  | Based on design calculation |                                         |
| 26      | Maximum A.C. resistance of conductor per meter at a maximum conductor temperature | Ohm/m  | Based on design calculation |                                         |
| 27      | Star reactance per meter of cable at 50Hz                                         | Ohm/m  | Based on design calculation |                                         |
| 28      | Star capacitance per meter of cable at 50Hz                                       | pF/m   | Based on design calculation |                                         |
| 29      | Charging current per conductor per meter at 6300/11000 Volts, 50Hz                | mA     | Based on design calculation |                                         |
| 30      | Maximum current carrying capacity of conductor in ground                          | A      | Based on design calculation |                                         |
| 31      | Maximum conductor temperature under continuous loading                            | °C     | Based on design calculation |                                         |
| 32      | Short circuit capacity of the cable for 1sec. duration                            | KA     | 71                          |                                         |
| 33      | Conductor temperature at the end of short circuit                                 | °C     | ≤250                        |                                         |
| 35      | Screen short circuit withstand capacity for 1sec. duration                        | KA     | 25                          |                                         |
| 36      | Armour short circuit capacity                                                     | KA     | Based on design calculation |                                         |
| 37      | <b>Cable resistance, reactance:</b>                                               |        |                             |                                         |
|         | a) for positive sequence                                                          | Ohm/km | Based on design calculation |                                         |
|         | b) negative sequence                                                              | Ohm/km | Based on design calculation |                                         |
|         | c) zero sequence                                                                  | Ohm/km | Based on design calculation |                                         |

Seal &amp; Signature of the Bidder

Seal &amp; Signature of the manufacturer

**FOR JOINING KITS FOR 11 KV XLPE, 1-CORE, 500 MM<sup>2</sup> COPPER CABLE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Sl. No.                                                                                | Description of Items                 | Required Particulars                                                                                                                                                                                                                                                                                                                                                                                                                         | Manufacturers Particulars |
|----------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| <b>Indoor Termination Kits for 11KV XLPE, 1-Core, 500 mm<sup>2</sup> Copper cable</b>  |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| 1                                                                                      | Name and address of the manufacturer | Shall be furnished                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 2                                                                                      | Type/model of the kits               | Shall be furnished                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 3                                                                                      | Application                          | For 11KV, 1-core, XLPE 500 mm <sup>2</sup> Copper Conductors                                                                                                                                                                                                                                                                                                                                                                                 |                           |
| 4                                                                                      | Installation                         | For Indoor installation in switchgear terminations                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 5                                                                                      | System                               | 11KV, effectively earthed system                                                                                                                                                                                                                                                                                                                                                                                                             |                           |
| 6                                                                                      | Country of origin                    | USA/UK/Germany/Switzerland/France/Japan/EU/Australia                                                                                                                                                                                                                                                                                                                                                                                         |                           |
| 7                                                                                      | Place of Manufacture                 |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| 8                                                                                      | Cable conductor                      | 500 mm <sup>2</sup> 1-core Copper Conductors                                                                                                                                                                                                                                                                                                                                                                                                 |                           |
| 9                                                                                      | Kit content                          | <ul style="list-style-type: none"> <li>- Heat shrinkable high voltage insulating and non-tracking tubing</li> <li>- Heat shrinkable stress control tubing</li> <li>- Stress relieving mastic strip</li> <li>- Truck resistant sealant tape</li> <li>- Cable preparation kit</li> <li>- Solder less earth connection kit</li> <li>- Compression lugs for 500 mm<sup>2</sup> Copper Conductors</li> <li>- Installation instructions</li> </ul> |                           |
| <b>Outdoor Termination Kits for 11KV XLPE, 1-Core, 500 mm<sup>2</sup> Copper cable</b> |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                           |
| 1                                                                                      | Name and address of the manufacturer | Shall be furnished                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 2                                                                                      | Type/model of the kits               | Shall be furnished                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |
| 3                                                                                      | Application                          | For 11KV, 1-core, XLPE 500 mm <sup>2</sup> Copper                                                                                                                                                                                                                                                                                                                                                                                            |                           |

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## CONDUCTORS AND CONNECTIONS

Overhead conductors carried by the switchyard structures shall be erected with such sags and tensions that when the conductors are subjected to load combinations, the factor of safety will not be less than 3.5.

Materials used for connections shall be stressed to not more than forty percent of their elastic limit. Provision shall be made for expansion and contraction with variation in conductor temperature and bus bars shall be arranged so they may be readily extended in length with a minimum of disturbance to existing equipment. The design of joints and connections shall be such as to permit ready dismantling.

Connectors shall be of an approved type. Connections dependent upon site welding techniques will not be permitted.

All bus connections and joints for aluminum conductor where applicable shall be of crimp and bolted palm types in accordance with the design parameters and the general technical requirements of this specification and the relevant standards.

Suspension and tension conductor clamps shall be of approved types and shall be as light as possible. Suspension and tension clamps shall be designed to avoid any possibility of deforming the stranded conductor and separating the individual strands.

Tension conductor clamps shall not permit slipping of, or damage to, or failure of the complete conductor or any part thereof at a load less than 95 percent of the ultimate strength of the conductor as stated in the schedule of particulars and guarantees.

All clamps and fittings and their components shall be electro-chemically compatible with the conductor material and those made of steel or malleable iron shall be hot dip galvanized. All bolts and nuts shall be locked in an approved manner.

Unless otherwise approved, connections shall be so arranged and supported that under no circumstances, including short circuit conditions, can the clearances between live metal and earth of earthed metal work or between other conductors be less than the specified distances.

Where dissimilar metals are in contact, approved means shall be provided to prevent electro-chemical action and corrosion. Unless otherwise approved, joints and surfaces of copper or copper alloy fittings shall be tinned.

Cleaning down and preparation of contact surfaces of connectors and clamps shall be to the approval of the Project Manager.





## DISCONNECTORS AND EARTHING SWITCHES

### 1. GENERAL

Disconnecting and earthing devices shall be in accordance with IEC 60129 and IEC 60265 (Part 2). Transformer disconnectors in transformer circuits without circuit breakers on the High Voltage side shall be in accordance with IEC 60265 and shall be capable of breaking the transformer magnetizing current. All shall be complete with supporting steel work and installed to permit maintenance of any section of the substation plant when the remainder is alive and shall be so locate that the minimum safety clearances stated in BS 7354 are always maintained.

In outdoor substations, disconnectors shall preferably be of the single throw double air break, center rotating post type or the double rotating post type with single air break and shall be to the approval of the Project Manager. Pantograph designs, or other alternatives, if applicable will be considered.

Disconnectors shall comply with the requirement of BS 5253 in respect of lightning impulse voltage tests. The contact resistance should be  $\leq 30\mu\Omega$

Circuit isolating switches shall be rated not less than specified. Bus section/coupler isolating switches shall be rated not less than the associated bus bars.

Isolating switches shall generally be designed of live operations and will not require switching current other than the charging current of open bus bars and connections or load currents shunted by parallel circuits. Main contacts shall be of the high pressures line type and arcing contacts, if provided, shall be to the Project Manager approval.

Service conditions require that isolating switches shall remain alive and in continuous service for periods of up to 2 (Two) years in the climatic conditions specified and without operation or maintenance. The contacts shall carry their rated load and short circuit currents without overheating or welding and at the end of the two year period the maximum torque required at the operating handle to open a 3-phase disconnector shall not exceed 340 Nm.

All feeder disconnectors and high level disconnectors where specified shall be fitted with approved three phase line earthing devices, mechanically coupled or interlocked with the main isolator, so that the earthing device and main isolator cannot be closed at the same time.

The earthing switch, when in the closed position, shall be capable of carrying the rated short time current for three seconds without the contacts burning or welding.

Isolating devices shall be interlocked with circuit breakers and as necessary to prevent the possibility of making or breaking load current. Except where electrical interlocking is provided each mechanism box shall accommodate the relevant Castell type key interlocks.

Disconnecter operation mechanisms shall be robust construction, carefully fitted to ensure free action and shall be unaffected by the climatic conditions at site. Mechanisms shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearing which are not of the self-lubrication type. The mechanisms shall be housed in a weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts, including the supporting steelwork shall be hot dip galvanized.

## **2. 33 KV ISOLATOR, EARTH SWITCH AND FUSE SWITCH**

### **(a) 33 KV Isolator, Off Load Type (Outdoor)**

The 33 KV Isolator, shall be a gang operated type, horizontal mounted and horizontal break, 3-phase, outdoor mounted, manual operating type along with the following feature:

- (a) Auxiliary contact operative through the operating mechanism of the isolator blade (6 normally ON and 6 normally OFF contacts).
- (b) Terminal connecting clamp suitable for being connected with AAAC/ ACSR conductor.
- (c) Earth pad for safety of the operating person. The operating lever shall be provided with locking device. Necessary grounding points shall be provided with connector suitable for being connected with 100 mm<sup>2</sup> stranded Cu wire.
- (d) Gland for multi core control cable.
- (e) 33 KV structure beam, complete operating mechanism for easy manual operation from the ground and grounding points with connection clamps for connecting with str. Cu wire.
- (f) All ferrous parts to be hot dip galvanized as per BS 729.
- (g) All electrical auxiliaries to be housed in a fully weather proof housing.

All other features as stated in the table of guaranteed data schedule should be applicable also.

### **(b) 33 KV Isolator with Earth Switch of the Line Side (Outdoor)**

Same as in specification of 33 KV isolator but with the added feature of earthing blade with will also hand operable from the switchyard by another handle and the operation of this earth blade with be mechanically interlocked with that of the main blade. The earth blade will be

of same current rating as the main blades and shall be earthed through a 100 mm sq. (cu) earthing conductor. Necessary aux. contracts for position indication and to provide electrical inter locking should be there.

### **(c) 33KV Fuse Switch with Holder and Fuse (Outdoor) for By-passing VCB and CT**

The 33 KV Fuse Switch, shall be 3 pole double-break gang operated type, outdoor vertical mounted, manual operating type which shall have a removable fuse in series. The switch shall be suitable for mounting on a pole (wooden, concrete or metal). A suitable structure shall be constructed by the Contractor with proper phase & ground clearances.

The circuit breaker/by-pass switch combination shall be designed in such a way that the circuit breaker primary circuits can be isolated by bolted links or switchable single-phase links or similar disconnect devices to enable maintenance of the CB with the by-pass switch closed supplying the substation, without encroaching on any safety clearances.

The purpose of the fused bypass switch is to enable the substation to be supplied while the circuit breaker/current transformer combination is being maintained or replaced. The Contractor shall design and install 2 sets of disconnect links in the circuit breaker/current transformer branch of the circuit so that the complete breaker/current transformer can be safely maintained with the bypass switch closed and providing 33 KV supply to the power transformer.

## **3. 11 KV ISOLATOR**

The 11KV Isolator, shall be of gang operated type, horizontal mounted and horizontal break, 3 phase, outdoor mounded, manual operated type.

## **INSULATORS**

### **1. DESIGN**

For open terminal type insulator, transformer terminal bushings and cable sealing ends the minimum specified creepage distance measured from the insulator metal cap to the base over the insulation cells shall not be less than 25mm per KV of rated voltage between phases.

All types of insulators shall satisfactorily withstand the specified climatic and service conditions. The strength of insulators as given by the electro-mechanical test load shall be such that the factor of safety, when supporting their maximum working loads, shall be not less

than 2.5.

Designs shall be such that stresses due to expansion and contraction in any part of the insulators and fittings do not lead to development of defects.

All insulators shall be manufactured in one piece. Jointing of solid or hollow porcelains is not permitted except by use of metal fittings.

Damaged insulators may not be repaired without the written consent of the Project Manager. Arcing horns are not required on post type and string insulators.

All insulators shall be porcelain construction type in accordance with IEC 60305. Post insulators shall comply with IEC 60273. Porcelain shall be sound, free from defects and thoroughly vitrified and the glaze shall not be depended upon for insulation.

The minimum specific creepage distances of outdoor insulators shall be as stated in the schedule of requirements. The shed shape, spacing and inclination shall be such as to withstand moderate pollution and the extremely heavy rainfall encountered at Site.

Glaze shall be smooth, hard of a uniform shade of brown and shall completely cover all exposed parts of the insulators. Outdoor insulator fittings shall remain unaffected by atmospheric conditions producing weathering, acids alkalis, dust and rapid changes in temperature that may be experienced under working conditions.

Porcelain insulators shall be secured in an approved manner, preferably by means of bolts or metal clamping plates with suitable packing material interposed.

Porcelain shall not engage directly with hard metal and where necessary, approved water and oil resistant yielding material shall be interposed between the porcelain and fittings. All porcelain clamping surfaces shall be approved quality applied in an approved manner and shall not be chemically active with the metal parts or cause fracture by expansion in service. Where cement is used as a fixing medium, the cement thickness shall be as small and as even as possible and care shall be taken to correctly center and locate the individual parts during cementing.

Suspension and tension insulators shall comprise porcelain units with ball and socket fittings. Each tension insulator shall consist of a string of insulator units and the ball socket joints of the units and of the associated fittings shall be in accordance with IEC 60305 (BS 137 Part 2) and IEC 60383 (BS Part 1).

Retaining pins or locking devices for cap and pin insulators shall be in accordance with BS 137.

Unless otherwise approved, the individual units of both the suspension and tension insulators sets shall be identical and interchangeable.

## **2. IDENTIFICATION**

Each insulator shall have marked on it the manufacture's name or trademark, the year of manufacture and the insulator reference. Tension and suspension insulators shall also be marked with the guaranteed electro-mechanical strength. Marks shall be visible after assembly of fittings and shall be imprinted and not impressed. For porcelain insulators, the marks shall be imprinted before firing and shall be clearly legible after firing and glazing.

When a batch of insulators has been rejected, no further insulators from this batch shall be submitted and the Contractor shall take adequate steps to mark or segregate the insulators constituting the rejected batch in such a way there is no possibility of the insulators being subsequently resubmitted for tests or supplied for the Employer's use.

**TECHNICAL REQUIREMENT AND GUARANTEE  
SCHEDULE FOR 33 KV ISOLATOR/EARTH SWITCH**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Description                                           | Unit    | BREB/PBS Requirement | Bidder's Guaranteed Values |
|-------------------------------------------------------|---------|----------------------|----------------------------|
| 1. Name of the manufacturer                           |         | Required             |                            |
| 2. Switch Type & Model                                |         | Required             |                            |
| 3. Rated Voltage & Frequency                          | KV/ H z | 33,50                |                            |
| 4. Maximum Continuous voltage                         | KV      | 36                   |                            |
| 5. Rated Current                                      | A       | 2000                 |                            |
| 6. Rated Short time current (3 sec)                   | KA      | 31.5                 |                            |
| 7. Impulse withstand voltage                          | KV      | 170                  |                            |
| 8. Power Frequency withstand voltage (1 min)          | KV      | 70                   |                            |
| 9. Creepage Distance                                  | mm      | Required             |                            |
| 10. Dimension of the supporting steel structure       |         | Required             |                            |
| Height                                                | mm      | Required             |                            |
| Width                                                 | mm      | Required             |                            |
| Length                                                |         | Required             |                            |
| 11. Weight of the phase units                         | Kg      | Required             |                            |
| 12. Phase center distance                             | mm      | Required             |                            |
| 13. Period of time, equipment has been in service     | Years   | 2                    |                            |
| 14. Period of time, equipment has been in manufacture | Years   | 5                    |                            |
| 15. Earth Switch                                      |         | Required             |                            |
| 16. Manufacturer                                      |         | Required             |                            |
| 17. Country of Manufacture                            |         | Required             |                            |
| 18. Manufacturer type designation                     |         | Required             |                            |
| 19. Reference Standard                                |         | Required             |                            |
| 20. Number of years disconnector type in service      |         | Required             |                            |
| 21. Nominal system Voltage                            | KV      | 33                   |                            |
| 22. Highest system voltage                            | KV      | 36                   |                            |
| 23. Frequency                                         | Hz      | 50                   |                            |
| 24. Rated Current                                     | A       | 2000                 |                            |

|     |                             |             |           |  |
|-----|-----------------------------|-------------|-----------|--|
| 25. | Type of operating mechanism |             | Hand      |  |
| 26. | Contact resistance          | $\mu\Omega$ | $\leq 30$ |  |

**Seal & Signature of the Bidder                      Seal & Signature of the  
manufacturer TECHNICAL REQUIREMENT AND  
GUARANTEE**

**SCHEDULE FOR 33 KV ISOLATOR/EARTH SWITCH**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Description |                                                   | Unit       | BREB/PBS Requirement | Bidder's Guaranteed Values |
|-------------|---------------------------------------------------|------------|----------------------|----------------------------|
| 1.          | Name of the manufacturer                          |            | Required             |                            |
| 2.          | Switch Type & Model                               |            | Required             |                            |
| 3.          | Rated Voltage & Frequency                         | KV/ H<br>Z | 33,50                |                            |
| 4.          | Maximum Continuous voltage                        | KV         | 36                   |                            |
| 5.          | Rated Current                                     | A          | 1250                 |                            |
| 6.          | Rated Short time current (3 sec)                  | KA         | 31.5                 |                            |
| 7.          | Impulse withstand voltage                         | KV         | 170                  |                            |
| 8.          | Power Frequency withstand voltage (1 min)         | KV         | 70                   |                            |
| 9.          | Creepage Distance                                 | mm         | Required             |                            |
| 10.         | Dimension of the supporting steel structure       |            | Required             |                            |
|             | Height                                            | mm         | Required             |                            |
|             | Width                                             | mm         | Required             |                            |
|             | Length                                            |            | Required             |                            |
| 11.         | Weight of the phase units                         | Kg         | Required             |                            |
| 12.         | Phase center distance                             | mm         | Required             |                            |
| 13.         | Period of time, equipment has been in service     | Year<br>s  | 2                    |                            |
| 14.         | Period of time, equipment has been in manufacture | Year<br>s  | 5                    |                            |
| 15.         | Earth Switch                                      |            | Required             |                            |
| 16.         | Manufacturer                                      |            | Required             |                            |
| 17.         | Country of Manufacture                            |            | Required             |                            |
| 18.         | Manufacturer type designation                     |            | Required             |                            |
| 19.         | Reference Standard                                |            | Required             |                            |
| 20.         | Number of years disconnector type in service      |            | Required             |                            |
| 21.         | Nominal system Voltage                            | KV         | 33                   |                            |

|     |                             |             |           |  |
|-----|-----------------------------|-------------|-----------|--|
| 22. | Highest system voltage      | KV          | 36        |  |
| 23. | Frequency                   | Hz          | 50        |  |
| 24. | Rated Current               | A           | 1250      |  |
| 25. | Type of operating mechanism |             | Hand      |  |
| 26. | Contact resistance          | $\mu\Omega$ | $\leq 30$ |  |

**Seal & Signature of the Bidder**

**Seal & Signature of the**

**manufacturer TECHNICAL REQUIREMENT AND GUARANTEE**

### **SCHEDULE**

### **FOR 11 KV ISOLATOR**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| <b>Description</b>                                    | <b>Unit</b> | <b>BREB/PBS Requirement</b> | <b>Bidder's Guaranteed Values</b> |
|-------------------------------------------------------|-------------|-----------------------------|-----------------------------------|
| 1. Name of the manufacturer                           |             | Required                    |                                   |
| 2. Switch Type & Model                                |             | Required                    |                                   |
| 3. Rated Voltage & Frequency                          | KV/ H z     | 11, 50                      |                                   |
| 4. Maximum Continuous voltage                         | Kv          | 12                          |                                   |
| 5. Rated Current                                      | A           | 2000                        |                                   |
| 6. Rated Short time current (3 sec)                   | KA          | 31.5                        |                                   |
| 7. Impulse withstand voltage                          | KV          | 75                          |                                   |
| 8. Power Frequency withstand voltage(1 min)           | KV          | 28                          |                                   |
| 9. Creepage Distance                                  | mm          | Required                    |                                   |
| 10. Dimension of the supporting steel structure       |             | Required                    |                                   |
| Height                                                | mm          | Required                    |                                   |
| Width                                                 | mm          | Required                    |                                   |
| Length                                                |             | Required                    |                                   |
| 11. Weight of the phase units                         | Kg          | Required                    |                                   |
| 12. Phase center distance                             | mm          | Required                    |                                   |
| 13. Period of time, equipment has been in service     | Years       | 2                           |                                   |
| 14. Period of time, equipment has been in manufacture | Years       | 5                           |                                   |



|                        |             |           |  |
|------------------------|-------------|-----------|--|
| 15. Contact resistance | $\mu\Omega$ | $\leq 30$ |  |
|------------------------|-------------|-----------|--|

**Seal & Signature of the Bidder**

**Seal & Signature of the manufacturer**

### TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE For 33KV, DOUBLE BREAK SWITCHED FUSE

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

| Description                                           | Unit       | REB Requirement | Bidders guaranteed values |
|-------------------------------------------------------|------------|-----------------|---------------------------|
| 1. Name of the manufacturer                           |            | Required        |                           |
| 2. Switch Type & Model                                | Dual Break | Required        |                           |
| 3. Rated Voltage & Frequency                          | KV/Hz      | 33,50           |                           |
| 4. Maximum Continuous voltage                         | KV         | 36              |                           |
| 5. Rated Current                                      | A          | 630             |                           |
| 6. Rated Short time current (3 sec)                   | KA         | 31.5            |                           |
| 7. Impulse withstand voltage                          | KV         | 170             |                           |
| 8. Frequency withstand voltage Power (1 min)          | KV         | 70              |                           |
| 9. Fuse Type                                          |            | Required        |                           |
| 10. Fuse Rating                                       | A          | 630             |                           |
| 11. Creepage Distance                                 | mm         | Required        |                           |
| 12. Dimension of the supporting steel structure       |            | Required        |                           |
| Height                                                | mm         | Required        |                           |
| Width                                                 | mm         | Required        |                           |
| Length                                                | mm         | Required        |                           |
| 13. Weight of the phase units                         | Kg         | Required        |                           |
| 14. Phase center distance                             | mm         | Required        |                           |
| 15. Period of time, equipment has been in service     | Years      | 2               |                           |
| 16. Period of time, equipment has been in manufacture | Years      | 5               |                           |

**Seal & Signature of the Bidder**

**Seal & Signature of the manufacturer**

## SUBSTATION EARTHING SYSTEM

### GENERAL

Circuit breakers, power transformers, voltage transformers, auxiliary transformers, earthing switches and other electrical apparatus shall each be connected to the main earth bus by means of a separate subsidiary connection. Gradient control mats shall be installed adjacent to each circuit breaker and disconnect switch mechanism box. Each mat shall be connected directly to the earth grid and the equipment.

Isolating supports, bus bar supports and cable sheaths may be earthed in groups by a separate branch connection from each item of equipment in the group the branch connections being connected by a single subsidiary connection to the main earth. Isolating and earth switch mechanism boxes shall be earthed by a connection separate from that effecting the earthing of the associated switch.

The main members of the steel structures shall be earthed by continuous copper connections bonded to the steelwork and these connections shall be connected separately at each column to the main or subsidiary earth. There shall be 2 connections to each structure and 1 to each piece of high voltage apparatus.

Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected against electrolytic corrosion.

Current transformer and voltage transformer secondary circuits shall be complete and shall be earthed at one point only (at the control building) through links situated in an accessible position. Each separate circuit shall be earthed through a separate link, suitably labelled. The links shall be of the bolted type, having necessary provision for attaching test leads.

The earth system shall be designed so as to include all overhead line terminal Poles, by bonding the overhead earth wire to the earth grid by means of a link which shall be capable of being removed for testing purposes.

The terminal pole shall also be included within the boundary of the earth grid by extending the grid if necessary.

Structures and masts for lighting and security surveillance equipment shall also be within the perimeter of the earth grid. No fixed low voltage equipment, with the exception of a warning or alarm button and intruder alarms, which shall be of the double insulation type, shall be erected outside the perimeter of the earth grid.

All control and relay panels shall have a continuous earth bus run of sectional area approved by the Project Manager along the bottom of the panels, each end being connected to the main earthing system. Metal cases of instruments and metal bases of relays on the panels shall be connected to this bar by conductors of sectional area approved by the Project Manager.

Loops shall be provided on the earthing system in positions approved by the Project Manager, for the attachment of portable earth connectors during maintenance. These will normally be in the earth bar run between the equipment and the base of the structure. They shall be formed separately from the bar and soldered or thermo-welded thereto. Where necessary, rods shall be provided at the tops of bushings or insulators for the attachment of portable earth clips. Necessary amount of Earth Pit shall be constructed for measuring earth resistance and connecting test equipment.

Earthing for any high frequency coupling equipment, if applicable, and surge diverters shall be via a copper rod driven directly into the ground at a position immediately adjacent to the equipment being earthed in addition to the normal earth connection.

### ***EARTHING SYSTEM DESIGN***

The earthing system shall be designed to meet the requirements of this specification and shall be in accordance with "The Guide for Safety in Alternating Current Substation Grounding" as published by the Institute of Electrical and Electronic Engineers Incorporated, Publication IEEE 80 and 142. The Contractor shall present calculations to show the earthing system meets these requirements and can be shown to be safe in terms of touch, step and transferred potentials. The earth resistance should be kept below or equal to  $0.2 \Omega$ .

Electrical measurements of the subsoil at various depths, up to 20 meters shall be made at the site of the substation in order to determine the layered effects of the ground from which the effective ground resistivity and hence the expected resistance of the proposed earth grid system may be predicted.

Soil composition may be highly corrosive and special consideration shall be given to this problem. The earth grid shall be effectively protected against corrosion. Cathodic protection, if considered, may adversely affect other equipment and shall be subject to approval by the Project Manager.

In actual design, the earthing system shall take the form of a combination of grids of buried conductors and earth rods driven vertically into the ground. Within the grid, conductors shall be laid in parallel lines at reasonably uniform spacing. They shall be located along rows of structures or equipment to facilitate the making of earth connections, where practical.

The main earth and each subsidiary earth shall have a sectional area, as required for 31.5 kA for 3 sec, in any case not less than  $120 \text{ mm}^2$  in any part of its length. Each branch connection shall have a sectional area of not less than  $95 \text{ mm}^2$ .

Connections to the grid of all non-current carrying metallic parts, which might become energized by chance, such as metal structures, building earth, equipment, earth rods, water pipes, etc. shall not be less than  $95 \text{ mm}^2$  and shall be of adequate size, current-carrying capacity and mechanical ruggedness.

The spacing between conductors forming the mesh system shall be such as to limit the grid potential rise to a value that limits the touch voltage to a value not greater than the maximum tolerable touch potential assuming a fault clearance time equal to that of the main protection equipment being provided.

Each group of earth conductor shall be connected to the main earth grid through connections having a sectional area of not less than  $120 \text{ mm}^2$  which shall be protected from corrosion. The grid shall be subdivided into a number of sections, interconnected with test links. These links shall be accessible from above-ground.

Areas of the grid, where high concentrations of fault currents can appear, as at neutral earthing connections, shall have reinforced conductor sizes where necessary, to handle adequately the highest fault current and its duration.

In case the equipment is widely spaced in the station, individual local grids may be established at the various equipment locations and the local grids shall be interconnected and connected to the overall earth grid. Interconnecting conductors shall not be less than the size of the conductor for main grid.

Metal parts of all equipment, other than those forming part of an electrical circuit shall be connected directly to the main earth system via a single conductor. The arrangement of the mesh earth system shall be such as to minimize the length of these single connections.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with fine topsoil. Where the soil is of a corrosive nature, precautions must be taken to protect the earth bar.

All trenches shall be backfilled in compacted 100 mm layers. All stones and other sharp objects shall be removed from the backfill by a suitable sieve.

Copper to copper joints on strip conductor shall be brazed, using zinc-free brazing material with a melting point of not less than 600°C, or by approved exothermic welding. All exposed joints shall be at a minimum height of 150 mm above floor or ground level. Earth conductor joints that are required to be broken for testing or maintenance shall have mating surfaces tinned.

After installation of the earth system the Contractor shall measure the resistance of the substation. The method used shall preferably be the "fall of potential" method, requiring the availability of a local low voltage supply but other methods using an earth resistance megger will be acceptable in the event of a local supply being unavailable.

In the case of surge (lightning) arrestors a local earth connection shall be made by driving electrodes into the earth near the arrestors and the lightning arrester earth conductor shall be connected to both the rod and to the common earthing grid of the station. The connection from arrester to earth shall be as short and as straight as possible. The conductor shall not be less than 120 mm<sup>2</sup>.

The measured earth resistance shall not exceed 0.5 ohm. A value higher than 0.5 ohm shall be subject to the approval of the Project Manager. The resistance shall be measured with all transmission line earth wires connected to the earthing grid. In the event of the substation resistance obtained with the foregoing installation being of a magnitude unacceptable to the Project Manager, then where practicable, the ground area enclosed by the earth system shall be increased by installing directly in the ground an additional copper conductor in the form of a ring around the site, or by additional conductors within the site. Alternatively, earth conductors can be directly buried radially outside the substation perimeter fence. The use of earth plates as current carrying electrodes is not acceptable. Any additional conductors shall be as directed by the Project Manager.

From the point of view of the possible damage to apparatus, the earthing system shall be such as to limit voltage appearing between the substation equipment and the main body of earth, so that insulation breakdown or burning does not occur on apparatus. For the same reason, voltage rise between earthed points in the substation shall be kept to a minimum. In addition, the effectiveness of any surge protection devices shall be fully realized by providing an adequate earth path. In this case, the earthing system shall not only be of low resistance, but of as low reactance as practicable.

**N.B:** For the earthing system design copper conductor shall be considered instead of copper earth electrode.

## **STEP AND TOUCH VOLTAGE**

The earthing systems shall be so designed as to keep the "step" and "touch" potentials within acceptable limits, thereby ensuring safety to the personnel. The aim shall be to ensure that under either normal or abnormal conditions no dangerous voltages can appear on the equipment or accessories to which a person has legitimate access.

The step and touch potential voltages obtained inside the site and at selected locations around the fence/gate shall also be measured by a suitable method acceptable to the Project Manager. Appropriate measures shall be taken to rectify the causes of any deviations from allowable values.

## **FENCE AND PERIMETER EARTHING**

The fence surrounding the substation shall be earthed to its own earth grid and the fence earth grid shall be connected to the main station earth grid at frequent intervals as approved by the Project Manager. A continuous conductor shall be laid outside the periphery of the substation site at a distance of 1.0 metre from the boundary fence and at a depth of 0.6 metres below the surface. This shall be welded to earth rods installed at adequate intervals and at points adjacent to each corner and immediately below any overhead line entering or leaving the site. The location of the mesh conductors shall be such as to enable all items of equipment to be connected to the earth system via the shortest possible route. All corner fence posts and posts adjacent to earth rods shall be effectively connected to the earth conductor. Gateposts forming part of the substation fence shall be bonded together with below ground connections and the gates themselves shall be electrically bonded to the posts.

The alternative approach of independently earthing the fence and placing it outside the earth grid area shall only be adopted if the above-mentioned procedures prove insufficient or impracticable. The Contractor shall provide calculations to show that this approach produces safe touch voltages at the fence and shall ensure that the fence is isolated from all other buried metalwork.

### Battery

The following battery size is the minimum expected and is provided as a guide only. The Contractor shall provide the detailed calculations of the loads and the expected loadings and the sizing of the battery for approval before implementation. The number of cells required in the battery shall be determined by the Contractor in accordance with the design of the DC requirements.

|       |                                             |                                                                                                             |
|-------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| i.    | Application                                 | Supply for remote control, operation, indication, protective and regulation apparatus, emergency light etc. |
| ii.   | Installation                                | Indoor (self-supporting unit)                                                                               |
| iii.  | Type/Model                                  | Nickel Cadmium Alkaline                                                                                     |
| iv.   | Operating Voltage                           | 110 V, DC                                                                                                   |
| v.    | Continuous discharge Rate                   | 10 hours                                                                                                    |
| vi.   | After discharge (10 hrs) final cell voltage | 1.1 Volt                                                                                                    |
| vii.  | Capacity (at the 10 hr rate)                | 250 A hour                                                                                                  |
| viii. | No. of cell                                 | 92                                                                                                          |
| ix.   | Discharging voltage                         | 1.1 - 1.7 volt per cell                                                                                     |
| x.    | Charging voltage (normal)                   | 1.45 - 1.55 volt per                                                                                        |
| xi.   | Charging voltage (max)                      | 1.70 volts per cell                                                                                         |
| xii.  | Type of container                           | Transparent plastic                                                                                         |
| xiii. | Mounting                                    | Cabinet                                                                                                     |
| xiv.  | Construction                                | Closed top                                                                                                  |



|     |          |                                                                                                                                                                                                                                                                                                                                               |
|-----|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| xv. | Standard | All equipment and materials shall be designed, manufactured and tested in accordance with the latest editions of applicable IEC standard unless otherwise specified in the specification. Other internationally acceptable standards will also be considered provided that relevant values are at least similar to those under IEC standards. |
|-----|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Features and Accessories:

The battery shall be Nickel Cadmium Alkaline type, negative plates shall have life equal to or greater than positive plates. The battery shall have built in protection against active materials shedding and grid corrosion and shall be assembled in heat-resistant, shock-absorbing containers. The containers and covers shall be connected together to form a leak proof bond against seepage of electrolyte.

The cell terminal posts of the inter-cell and end cell connectors shall have adequate current carrying capacity and shall be of lead alloy or lead alloy reinforced with copper inserter. The container shall be filled with sufficient quantity of Alkaline complying with internationally acceptable standards to ensure that the surface of Alkali is leveled with the level mark.

Cells shall be equipped with necessary bolts and alkali resisting units, shall be furnished with all the bolts.

Plates shall be hung suspended without touching the bottom of the containers. Containers shall provide sufficient sediment space so that the plates in the cell, as well as to avoid cleaning of cells during the expected life of the battery.

110% of the required electrolyte meeting the manufacturer's specification shall be supplied at the correct filling specific gravity with each battery. The electrolyte shall be packaged in 15 gallons or less plastic coated steel drum or in plastic containers. After discharging off the specified rated capacity, the battery shall have the voltage including the internal resistance drip of all inter cell and inter rack connectors not to drop below 1.10 VPC.

The battery rack shall be a few step structural steel and shall be painted with 2 coats of acid resistant Grey paint. Inter rack connector terminal lugs shall be provided with each rack.

Battery shall be shipped dry with concentrated electrolyte in separate containers.

### The following accessories shall be supplied with each battery set:

- Two lead plated lugs for No. 4/0 AWG copper cable. Two portable hydrometer syringe.
- One set of socket wrenches to fit nuts.
- Polyethylene bottle with extendable tube for topping up the battery. Special voltmeters to measure cell voltage.
- One gallon of anti-corrosive paint.

### The following spare parts shall be supplied with each battery set:

- One positive plate One negative plate
- One spare container and cover. One vent plug
- One gallon electrolyte.

The battery shall be tropicalized.

All other features as stated in the table of guaranteed data schedule shall be applicable also.



## Battery Charger

### General

#### Scope

This Standard Specification stipulates the requirements for the supply of spare 110 Volt DC Three Phase 70 A Float Cum Boost Charger (FCBC) with Diode Voltage Regulator (DVR) Battery Charger. This battery charger should be capable to charge the battery bank and supply (110V DC) for the substation DC network.

#### Standards

The battery charger equipment shall be designed in compliance with the following International Electro-technical Commission (IEC) Standards:- IEC 60146-1-1: Semiconductor converters

#### Site Operating Conditions Site

##### Condition:

- a) Maximum altitude above sea level: 1000m
- b) Maximum ambient temperature: 50°C
- c) Minimum ambient temperature: 0°C
- d) Average yearly temperature: 30°C
- e) Maximum relative humidity: 98 %

#### Indicative Dimensions of Existing Battery

##### Charger:

Existing battery charger panel dimension (approximate):

Width: 800±5mm

Height: 2100±10mm

Depth: 800±5mm

## General

Rating

## Technical Requirement

- identification Charger Control

The load voltage shall be kept within the range of 90%-110% nominal over a load range of 0-100%. Automatic voltage controlling devices (e.g. Series dropper diodes) shall be provided to maintain the load voltage within this specified range. Suitable time-delay shall be incorporated to prevent the operation of such controllers during a switching duty cycle or a switching transient situation.

The charger output voltage shall be maintained within  $\pm 1\%$  of present voltage irrespective of  $\pm 15\%$  mains voltage variation  $\pm 5\%$  frequency variation or 0-100% load current variation.

The charger output voltages and current limits shall be independently adjustable but preset at the manufacturer's works to suit the battery supplied. The charge voltage range shall be adjustable between 100-140% of nominal battery voltage. The current limit shall be adjustable between 40-100% of rated charger output.

FCBC provided with an auto/manual selection push/ touch button and FLOAT/BOOST selection push/touch button through keypad on the front door of the panel with password protection for each four (4) modes of operation mentioned below:-

- In auto float mode, the charger operates in float mode if the battery current is less than the battery current limit, then the charger will go to the boost mode automatically.
- In auto boost mode, the charger maintains a constant set value of boost voltage. If the battery draws more than battery current limit value, then the voltage is dropped and maintains a constant battery current. In this case if boosting charging is completed, the charger will revert back to float mode automatically for their normal operation.
- In manual float mode, the charger is selected to operate in manual float mode by using front panel keys (auto/manual and float/boost keys), by selecting the manually. Then the charger is operated in float mode respective of battery current. During this mode it maintains of float voltage.
- In manual boost mode, the charger is selected to operate in manual boost mode by using front panel keys (Auto/Manual and float/Boost keys) by selecting them manually. Then the charger is operated in boost mode irrespective of battery current. During this mode it maintains set value of boost voltage. In this case if boosting charging is completed (by means of time, charger will revert back to float mood automatically for their normal operation).
- Under normal condition the charger supply the voltage to load by trickle charging the battery In case of mains failure under normal condition the battery will start supplying the load without any interruption.
- Upon resumption of AC mains power the charger develops voltage and resume normal operation of supplying load and float charging the battery. However the battery may have been discharged and needs boosting charging. Hence FCBC will go to the boost mode automatically in case of charger is in auto mood. After completion of boost charging (battery full charged) FCBC will come back to float mode and reconnects the load. FCBC will revert back to float mood based on their condition of the boost time setting or battery current limit setting.

### Charger Protective Equipment

#### 1. General

Unless otherwise specified, the load shall not be disconnected from the battery in the event of a failure of the mains supply, the battery or the charger.

Current limiting circuitry shall be incorporated into both the boost charger and the float charger to prevent damage to the chargers or the battery, in case of a short-circuit, overload or accidental polarity reversal.

An earth leakage detector shall be provided for the 110V D.C. Battery to detect the current leakage from either the positive or the negative terminal.

HBC fuses shall be provided at the mains input and at the charger output. Each fuse holder shall be provided with a label indicating the fuse rated current and application. The charger shall be tripped from a normally closed contact upon detection of failure of battery room ventilation by a sensor supplied by others.

The charger should have also the protection Surge suppressors, soft start feature, total current limit and short circuit, rectifier protection fuse, blocking diode, control circuit and voltmeter fuse, control cards (each) temperature protection.

## 2. Alarms

Devices for detecting the following alarm conditions and initiating visual display shall be provided.

- (a) Mains failed (in case of a 3-phase charge, failure of one phase shall initiate alarm).
- (b) Fan failed (Where installed).
- (c) Charger temperature high.
- (d) Charger output over voltage.
- (e) Charger output under voltage.
- (f) Load supply under voltage.
- (g) Load supply over voltage.
- (h) Charger phase imbalance.
- (i) Earth leakage (where installed).
- (j) Phase sequence fail.
- (k) Charger fail.
- (l) Charger overload
- (m) Battery under voltage
- (n) Battery over voltage
- (o) Battery MCB trip
- (p) Firing card fail

## 3. Monitoring and Control Equipment

- (a) Mains ON/OFF switch (key lockable);
- (b) BOOST/FLOAT charge manual selector or pushbutton (key operated);
- (c) Ammeter, charger output;
- (d) Ammeter, battery load;
- (e) Voltmeter, charger output;
- (f) Voltmeter, load output;

### (g) LED type indicating lamps:

- (i) Mains failed (red)
- (ii) Earth leakage (where installed) (red)
- (iii) Electrolyte level low (where installed) (red)
- (iv) Charger failed (red)
- (v) Fan failed (where installed) (red)
- (vi) Charger temperature high (red)
- (vii) Battery temperature high (red)
- (viii) Charger voltage low (red)
- (ix) Charger voltage low (red)
- (x) Load voltage high (red)
- (xi) Load voltage low (red)
- (xii) Battery room ventilation failed (red)
- (xiii) Mains on (green)
- (xiv) Float charging on (blue)

- (xv) Boost charging on (amber)
- (xvi) Lamp test push button

**Technical Data to Be Submitted**

The following information shall be submitted for assessment upon request by the Employer/Engineer:-

- (a) Type test certificate of offered or higher type battery charger as per IEC 60146 standard from any of Internationally Recognized Independent Testing Laboratories. In case the Type Test for higher size battery charger, bidder should have offered the provided type tested battery charger.
- (b) Factory Routine Test data of the battery charger.
- (c) General arrangement drawing of charger panel.

**Approval Of Drawing & Specification**

General arrangement Drawing, Technical Particulars & guarantees etc, shall be submitted to the purchaser by the bidder for approval, prior to the manufacturing of the goods. The bidder shall have to submit four

- (4) sets of the same for approval within 15 days from the date of issue of purchase order.

**Operating Manual and Documentation**

Each Battery Charger shall be provided with a set of operating manuals in English language containing:

- a) Detailed description of operation and function
- b) Wiring diagram
- c) Detailed description of card and their connection
- d) Detailed description of PCB board

**Nameplate**

The following information shall be given on the name plate of each battery charger panel:

- a) Manufacturer's name
- b) Contract Number
- c) Model, year of manufacture and identifying number
- d) Allowable ambient temperature range, safety warning, power supply and technical specifications
- e) Reference Standards
- f) Manufacturer logo or trademark and brand name, Supplier name
- g) Weight and size of equipment (WxHxD in mm)





### Technical Requirement for Battery and Battery Charger

| Sl. No.   | Description    | Unit | Requirement             |
|-----------|----------------|------|-------------------------|
| <b>A.</b> | <b>BATTERY</b> |      |                         |
| 1         | Manufacturer   |      | To be mentioned         |
| 2         | Model no       |      | To be mentioned         |
| 3         | Electrolyte    |      | Nickel Cadmium Alkaline |

|           |                                                                                |            |                      |
|-----------|--------------------------------------------------------------------------------|------------|----------------------|
| 4         | Installation                                                                   |            | Indoor               |
| 5         | Operating voltage                                                              | V DC       | 110                  |
| 6         | Continuous Discharge Current at rate of 10 hour & Final Cell Voltage 1.1 Volt. | Amp        | 25                   |
| 7         | Charging Voltage (Maximum)                                                     | Volt       | 1.54-1.70 Per Cell   |
| 8         | Normal float charge rate                                                       | A          | To be mentioned      |
| 9         | Maximum boost charge rate                                                      | A          | To be mentioned      |
| 10        | Voltage per cell                                                               | V/per cell | 1.2                  |
| 11        | <b>Capacity at 10 hour rate</b>                                                | Ah         | 250                  |
| 12        | <b>Number of cells</b>                                                         | Nos        | 92                   |
| 13        | Float voltage per cell                                                         | V per cell | 1.4-1.42             |
| 14        | Discharge voltage                                                              | V per cell | 1.1-1.7              |
|           | Battery voltage at end of the duty cycle                                       | V          | 1.1V per cell        |
| 15        | Maximum charging rate                                                          | A          | 50                   |
| 16        | Ampere-hour efficiency at 10 hour rate                                         | %          | To be mentioned      |
| 17        | Ampere-hour efficiency at one hour rate                                        | %          | To be mentioned      |
| 18        | Dimensions of cells                                                            | mm         | To be mentioned      |
| 19        | Weight of cell complete with electrolyte                                       | kg         | To be mentioned      |
| 20        | Internal resistance per cell when fully charged                                | ohms       | To be mentioned      |
| 22        | Material of battery case                                                       |            | To be mentioned      |
| 23        | Standard                                                                       |            | IEC 623              |
| <b>B.</b> | <b>CHARGER</b>                                                                 |            |                      |
| 1         | Manufacturer                                                                   |            | To be mentioned      |
| 2         | Model No                                                                       |            | To be mentioned      |
| 3         | Rectifier Type                                                                 |            | Thyristor            |
| 4         | AC input voltage                                                               | V          | 415±15%              |
| 5         | Input AC frequency                                                             | HZ         | 50±5%                |
| 6         | DC Output voltage                                                              |            |                      |
| 7         | a) Normal Charge                                                               | VDC        | 110±10%              |
|           | b) Float Charge                                                                | VDC        | 1.42 for 110±10%     |
|           | c) Boost Charge                                                                | VDC        | 1.70 volt per cell   |
|           | Output current (continuous)                                                    | A          | Minimum 80           |
| 8         | Charger Control                                                                |            | As per specification |
| 9         | Charger Protection                                                             |            |                      |
|           | a) Protective Equipment                                                        |            | As per specification |
|           | b) Alarms                                                                      |            | As per specification |
|           | c) Monitoring and Control                                                      |            | As per specification |
| 10        | Rated Batter Current                                                           | A          | To be mentioned      |
| 11        | Efficiency                                                                     | %          | To be mentioned      |
| 12        | Ripple voltage                                                                 | %          | To be mentioned      |
| 13        | Type of AVR                                                                    |            | Static               |
| 14        | Standard                                                                       |            | IEC-146              |
| <b>C.</b> | <b>CHARGER CUBCLE COMPLETE</b>                                                 |            |                      |
| 1         | Manufacturer                                                                   |            | To be mentioned      |
| 2         | Overall dimensions                                                             |            | To be mentioned      |
| 3         | Total weight                                                                   |            | To be mentioned      |

## OVERHEAD EARTHING SCREEN

Earthed screens shall be provided at all substations to protect the substation equipment from direct lightning strikes. The screens shall be of aluminum clad steel wires of not less than 50 sq. mm total section, and connected to provide low impedance paths to earth.

In accordance with international standards, the 'Rolling Sphere' method shall be used to determine the required protection. The layout of the earth wires shall be such that equipment to be protected generally lies within areas bounded by two or more conductors.

The earth screens shall be suitable for extension to protect the substation equipment to be installed in future stages of development.

Connections to the main underground earth grid shall be made of suitably rated copper strap at each support unless the galvanized steel support structure has sufficient area and current carrying capacity. Earth wires shall be held in clamps with free pin type joints between clamps and supports.

Connections shall be provided for the terminations of the earth wires of the overhead lines, including bimetal connectors where necessary.

The design of all structures shall comply with the requirements of the standards and specifications with consider the layout of the 33/11 kV sub-station. In particular the design shall ensure that in the event of the breakage of one earth wire, the Factor of Safety is not less than 1.5.

### 1.1.14 Control Cable and LV Power Cable

The multi core control and LV power cables shall be of 1000V insulation class having copper (Cu) cores stranded or solid, PVC insulated and sheathed.

The control cable used for CT connection shall have cross section 4mm<sup>2</sup> (min). Cables used for control a signaling shall have cross section ranging from 2.5 to 4 mm<sup>2</sup> with at least 20% spare cores. Each core insulation shall be of a different color or numbered for easy identification.

The LV power cables for the main AC supply from the 200 kVA transformer to AC distribution panel shall be 95 mm<sup>2</sup> 3.5 core type and all other AC connections shall be by appropriate size cables the minimum size being 16 mm<sup>2</sup> 3.5 core for 3 phase and two core for single phase. The DC power supply from charger to battery to DC distribution panel shall be done by cable 25mm<sup>2</sup> tow core and all other DC distribution shall be by appropriate size of cables, the minimum size will be 10mm<sup>2</sup>. The 95 mm<sup>2</sup>, 3.5 core LT cables will be armored type.

The item includes suitable terminal lugs/connectors, termination kits, termination kits, identification tags etc. complete in all respects.

Design requirements for Control, Relay Protection, Metering & Telecom equipment

Typical Substation Control System requirements

### Overview

The Substation Automation System (SAS) shall comprise of the following subcomponents:

- Substation Control System (SCS)
- Communications Network
- Time Synchronization
- Substation Human Machine Interface (HMI)
- Engineering Workstation (EWS)
- SAS Integration with Substation

Note that in all design aspects, cybersecurity principles shall underpin the SAS implementation.

The SAS shall be responsible for all data acquisition, automation, monitoring and control of the substation electrical infrastructure which is largely based on a modern substation automation system design. The SAS shall use the internationally recognized IEC 61850 suite of standards for protection, automation & control. The gateway and substation HMI shall communicate with all the protection IEDs for SAS data using its embedded IEC 61850 MMS Client.

The physical device name of the IED in the CID file is critical and used as part of the object model defined in the IEC 61850 standard. The naming convention that will be used will be applied consistently across all Software Configuration Tools.

The substation gateway, mounted in a dedicated gateway cabinet, shall subscribe to the configured report control blocks (RCBs) in each IED in order to retrieve SAS data contained in predefined datasets. There are two types of reporting schemes detailed in the standard as part of the IEC 61850 MMS Client which shall be used. These are the buffered and unbuffered report control blocks. All digital inputs (alarms/indications/protection trips) that must be sent to the gateway shall be assigned to two datasets associated with Buffered Report Control Blocks (BRCBs). All analogue data (power, voltage, current, etc.) that must be sent to the gateway shall be configured in datasets associated with Un-buffered Report Control Blocks (URCB). URCB's do not buffer any state changes during a communication failure between the gateway and the IED. The varying nature of analogue quantities justifies the use of URCBs in order to optimize the memory resources of the IED for other critical tasks. Furthermore, the use of BRCB's ensures that critical indications/trips are preserved/buffered should a communication loss between the substation gateway and the IED occur.

The list of signals for the substation will be made available during the Factory Acceptance Test (FAT) of the SAS.

The Substation gateway shall aggregate data received from the substation and perform the task of a gateway to exchange the required signals to the BREB SAS Master station. The SAS shall communicate to the BREB Control Centre using the IEC 60870-5-104 tele-control protocol.

The Protection IED's shall comply fully with the IEC 61850 Edition 2.1 standards or later edition, as applicable.

The managed Ethernet network that is to be installed shall be substation hardened to IEC 61850-3 and shall accommodate redundant 48 Vdc power supplies. 19" rack-mountable switches are preferred, with

the prerequisite that the network shall accommodate all the devices that will connect to it and provide for 25% spare port capacity. The devices shall be mounted in the gateway cabinet. All fibre optic connections to the switches will be realised via rodent-resistant ruggedized fibre optic cables using LC connectors and at least four copper ports shall be included for engineering use.

Critical station alarms monitoring is achieved by means of an IEC 61850 compliant remote I/O unit which will be mounted in the gateway cabinet. These alarms include but are not limited to VT fail alarms, DC fail alarms, charger alarms, AC fail alarms, IED (relay) watchdog alarms, etc. The complete list of station alarms which are hard-wired to the I/O unit will be made available during the Factory Acceptance Test (FAT) of the SAS.

The I/O unit(s) shall communicate to the gateway via IEC 61850 MMS and shall be treated as substation IEDs in the SAS.

While IEC 61850 is the preferred communications standard for all substation devices, it is acknowledged that some devices may only support alternative communications standards. As such, Modbus/TCP will be acceptable for intelligent battery chargers and the integration of meter readings into the Substation Automation System.

Every meter, battery charger, MCCB status of ACDB & DCDB shall be incorporated with SAS through MODBUS/DLMS COSEM protocol.

Detailed GTPs for the SAS, every component in the control room (relay, meter trip relay, trip coil, supervision coil, energy meter), as well as the requirements of the 11kV PCM panel and 33kV PCM panel (Feeder, Transformer, Indoor AIS) shall be included with the tender documents long with the corresponding GTPs.

It must be noted that the design requirements of the 33 kV control, signalling and relay panel and the design requirements of the SAS system shall be different.

### **Naming and conventions**

An IEC 61850 dataset containing Functionally Constrained Data Attribute items shall be named according to its intended purpose once associated with a GOOSE Control Block. For example, a dataset containing items to be used for interlocking may be called CTRL or ILOCK and a dataset containing items to be used for tripping purposes (including breaker fail) may be called TRIPS.

A GOOSE Control Block shall be configured according to the following:

- The MAC address shall reflect the source bay number in the last byte of the multicast MAC address. The number shall depict the decimal number of the bay. This is done to assist in locating GOOSE messages in monitoring tools such as Wireshark.
- The App ID field shall be structured to indicate the source bay number in the first byte and the GOOSE instance in the second byte.
- The GOOSE VLAN ID and Priority shall be as shown agreed in the detailed design phase.
- The GOOSE Application ID (GoID) shall be named by using a unique bay identifier.

Furthermore, if the primary purpose of the GOOSE message is for trip signalling, then the name shall reflect such.

### **IEC 61850 GOOSE Dataset contents**

The items in a dataset to be associated to a GOOSE Control Block shall be sourced from the logical node that describes the functionality and shall not be taken via any other signal manipulation (e.g. the Disturbance Recorder function block) first. For example, an earth switch position shall be sourced from the Pos DPC (ST FC) of the XSWI or CSWI logical node.

### **IEC 61850 GOOSE Control Block and Dataset locations**

All Datasets and GOOSE Control Blocks for an IED shall be located in LLN0 of Logical Device 0 (LD0), or equivalent logical device, of said IED.

### **IED Logic requirements**

The logic associated with an IED shall be performed in the IED itself. No logic shall be partially implemented in the GOOSE transmitting IED as this makes troubleshooting extremely cumbersome. All inputs (physical as well as GOOSE virtual inputs) shall be modelled by passing the inputs to the appropriate function block reflecting the IEC 61850 Logical Node that represent the signal.

## **Substation**

### **Control General**

Local control at the substations is achieved by means of the user interface of the IED in each protection scheme as described above. A touchscreen capable IED is therefore preferred with a colour display. In addition, a substation HMI shall be available at the substation for centralised local control and monitoring.

The IEDs shall be required to present a bay “mimic” for monitoring and operating purposes.

Any switching sequencing as well as interlocking functionalities are also the responsibility of the IEDs. Accurately time stamped alarms and indications are to be made available to the substation gateway by means of IEC 61850 MMS reports.

Inter-device signalling to be achieved by means of IEC 61850 GOOSE messaging. The use of GOOSE provides for simplified data exchange.

### **Local Control**

Control from the bay control and/or protection IEDs shall be realised by means of the graphical bay mimics displayed on the IEDs. IED faceplate pushbuttons shall be used to control switchgear positions provided the Local/Remote selection is in the Local position.

The following additional safety measures shall be employed when operating the MV switchgear board:

- Manual control shall only be possible by means of a stand-off pendant switch with a long cable (umbilical cord) to allow the operator to stand a safe distance away from the board;
- Control from the IED pushbutton shall be time-delayed for example by 15 seconds to allow the operator to initiate the control and have enough time to clear the vicinity and stand a safe distance away from the board.

### **Substation HMI**

A substation HMI is the preferred operating interface to be used for monitoring and control with the aim of ensuring safety and minimising operating errors. The HMI shall be an independent system and may be an integral component of the gateway devices provided the HMI functionality is not impeded due to its integration.

### **Remote Control**

Remote control shall be facilitated by means of a communication gateway that will be connected to the BREB Control Centre by means of the IEC 60870-5-104 communications standard. Cyber security in the form of electronic perimeter protection shall be realized by means of a network security appliance that is recognized as a leader in the industry-recognized Gartner Magic Quadrant.

The device shall be capable of deep packet inspection of IP traffic including Industrial Control System protocols such as IEC 60870-5-104, and IEC 61850, packets. The proposed cyber security device shall be compliant with IEC 61850-3 and must be centrally manageable.

The HMI/gateway cabinet shall house an IEEE 1588v2 Power Profile capable, GPS synchronized clock with IRIG-B, NTP and PTP capabilities for substation-wide time synchronization purposes.

### **Engineering Workstation**

The Engineering Workstation (EWS) shall be a substation-hardened industrial computer that shall provide the necessary functionality and graphical interface for configuring, managing and collecting information and records from the Substation Automation System (SAS).

The EWS shall be required to:

- Provide a central “on-site” repository of the configuration management for the entire substation system. This includes drawings, manuals and component configurations.
- Storage and display of disturbance records - All recorded data from the IEDs with integrated disturbance recorders shall be automatically uploaded via IEC 61850 (event triggered or once per day) to the EWS and stored on the mass storage device. Retrieval may be facilitated via the gateway device.
- Disturbance analysis – The EWS shall have all the necessary software to evaluate all the required information for comprehensive post-fault analysis.
- IED parameter settings – It shall be possible to access all the Protection IEDs from the EWS. The setting of parameters or the activation of parameter sets shall only be allowed from the EWS after authenticating and authorizing the user appropriately.

The EWS shall be rack-mountable and shall be mounted in the Gateway Panel.

The EWS shall communicate via IEC 61850 to all the IEDs in the SAS. SNMP shall be used to communicate with the substation LAN equipment.

### **Substation Communications Infrastructure (Substation LAN)**

A fibre optic network will be deployed within the substation building for local communications to all the IEDs, HMIs and Gateway.

An industrial-grade, substation hardened, switched Ethernet network shall be used to manage the fibre optic network infrastructure at the substations.

The network topology shall be such that each IED shall connect directly to the network switches using both network interfaces in a parallel redundancy configuration (using PRP). No ring topologies shall be permitted particularly where the IEDs are required to be an integral part of the network topology. The substation switches shall support the Precision Timing Protocol as per the IEEE 1588v2 Power Profile standard. Non-PRP capable equipment shall integrate via a suitable RedBox solution. No proprietary redundancy solutions shall be acceptable.

The switches shall be configured to isolate the different traffic types into dedicated Virtual Local Area Networks (VLANs).

GOOSE messages shall take full advantage of traffic separation using VLAN IDs and data prioritisation. Multicast MAC addresses must be significant and must relate to the source IED. Other GOOSE parameters shall also be significant and shall relate to the source IED.

The fundamental design criteria for the implementation of a communications networks in a SAS is high availability, high reliability and maintainability. The system design shall provide a solution employing the abovementioned design criteria to derive the maximum benefits from an IEC 61850 Substation Automation System. High availability shall be realised by means of a design using redundant devices and redundant cabling where this is practically achievable. High reliability is achieved by product selection based on industrial networking principles and guidelines. The product selection shall exceed minimum build-quality and design-quality criteria. Maintainability shall be realised through suitable network monitoring and configuration management. These switches are shall be ruggedized industrial Ethernet devices which shall be compliant to the following typical requirements:

- Rated for reliable operation in harsh electrical environments:
  - IEC 61850-3 and IEEE 1613 (Electric power substations)
  - IEC 61000-4

- IEC 60068-2
- IEC 60255-21
- Rated for error free operation in high EMI environments:
  - IEEE 1613 Class 2 error free performance under EMI stress for fibre-based networking devices
  - IEC 60255-26
  - IEC 61000-4
- Fibre optic ports should support both short (SX) and long haul fibre (LX)
- Rated for operation over a wide temperature range:
  - -40°C to 85°C (+185°F)
  - Passive cooling – no fans.
- Rated for high availability:
  - Dual redundant power supplies
- Industrial terminal blocks for power and I/O connections

## IP address allocations

All IP addresses configured for the Substation Automation Systems shall be within the private range (RFC1918 – Address Allocation for private internets) of available IPv4 addresses as assigned by the Internet Assigned Numbers Authority (IANA).

The allocation shall be done according to the Classless Inter-Domain Routing (CIDR) method as defined by the Internet Engineering Task Force (IETF).

A typical IP address range that shall be used for the Substation Automation systems shall take the form of a typical range such as 172.16.X.0/22 and this range shall be further subnetted and allocated as described in table below.

| Network Address       | Allocation                         |
|-----------------------|------------------------------------|
| 172.16.X.0/25         | Network Management                 |
| 172.16.X.128/25       | Engineering Access                 |
| 172.16.X.0/24         | Substation Automation System (SAS) |
| Network 172.16.X.0/24 | Tariff meters                      |
| 172.16.X.0/24         | Unallocated at present             |

## Virtual Local Area Networks (VLANs)

Virtual local Area Networks (VLANs) shall be applied on the system to manage the efficiency on the network. The managed Ethernet switches will be configured with a weighted round robin (WRR) Quality of Service (QoS) regime.

The following VLANs are used on the system:

- Substation Automation System VLAN
- GOOSE VLAN
- Management VLAN
- Engineering VLAN
- Metering VLAN

## Time synchronization



Time Synchronization forms a critical component of the SAS. A rack-mounted GPS Clock (residing in the Gateway cabinet) shall be the reference clock (NTP stratum 0) in the SAS. The GPS clock shall be designed to operate in substation environments with  $\pm 100$  ns accuracies. This clock synchronizes to UTC using GPS satellite transmissions that are received via the GPS antenna. A surge arrestor shall be mounted and earthed in the substation gateway panel and shall be connected to the antenna on one side and the GPS clock on the other side thereby providing protection for the GPS clock.

The SAS shall incorporate two time servers, a main and a backup time server (which may be located at the control centre) for time synchronization redundancy. The time servers shall distribute the time to all IEDs using the Network Time Protocol (NTP). Each IED shall be configured with a main and backup NTP server with a 60s refresh rate. Should the main NTP server fail, the IEDs will request time from the backup NTP server. In addition, the managed Ethernet switches, I/O units, Engineering Server, etc., shall be time synchronized using NTP.

The following settings and philosophies will be applied in the SAS:

- Bangladesh is in the Bangladesh Standard Time (BST) time zone with an offset of +6 hours from UTC.
- Each IED in the SAS will be configured with the BST time-zone offset.
- All time distribution shall be done in UTC time.
- Daylight savings is not observed in Bangladesh. Hence, no Daylight Savings Time (DST) subtraction from UTC time will be done.

Loss of satellite communications will actuate the alarm contact which is wired to the I/O unit.

#### **Substation Human Machine Interface (HMI)**

The Substation Human Machine Interface (HMI) system in the substations shall be responsible for meeting the following objectives required for a Substation Automation System (SAS):

- Provides a user interface for the engineer/operator to safely monitor and control the electrical infrastructure at the substation.
- Provides limited visualization and analysis capabilities for power system measurands and disturbances.
- Centrally managed annunciator system, historical alarm summary/sequence of events (SoE) and control operation logs.

#### **Typical Relay Protection System requirements**

The substation automation system solution will comprise of the following configuration of IEDs per switchgear panel with each IED incorporating protection and control functionality.

- 33 kV and 11kV outgoing feeder panel: 1 IED
- 11V Incoming Feeder: 2 IEDs (Overcurrent & Earth Fault, Standby Earth)
- 33kV Transformer: 3 IEDs (Overcurrent & Earth Fault, Transformer Differential, Automatic Voltage Regulation)

The IEDs shall be based on microprocessor technology and shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall perform all bay related functions, such as protection, commands, bay interlocking, data acquisition, data storage and event recording and shall provide inputs for status indication and outputs for commands.

The IEDs will be mounted on the LV compartment panel door of the switchgear panels and shall be directly connected without any need for separate interposing equipment or transducers. The IEDs shall have the following features as a minimum:

- Minimum of 8 analogue channels
- Binary inputs, signal relays and command relays shall be provided as per respective feeder protection scheme

- 8 programmable LEDs on the front of the unit for indications
  - Instantaneous Phase Overcurrent Protection
  - Instantaneous Earth Fault Protection
  - Inverse Time Phase Overcurrent Protection
  - Inverse Time Earth Fault Overcurrent Protection
  - Standby Earth Fault Protection (for 11 kV Incoming Feeders) which must be provided as a separate IED
- 
- Automatic Voltage Regulation (for 33 kV Transformers) which must be provided as a separated IED
  - Transformer Differential Protection and Restricted Earth Fault Protection for 33 kV transformer protection
  - Integrated Arc-Flash protection for IEDs used in metal clad switchgear applications
  - Breaker Fail Protection
  - Overvoltage/ under voltage Protection
  - Synchro check function
  - Built-in mimic display with controls for operating the switchgear. In the event of failure of the bay unit a backup system for emergency operation should be provided.
    - Sequence of Events Recorder with a buffer for 256 events and a resolution of 1ms. The events that are to be recorded shall be freely programmable. These can be alarm/trip signals, external signals connected to optocoupler inputs, internal signals, etc. Once events are defined, they are recorded in chronological order as they occur.
    - Disturbance Recorder function which can record 9 analogue values, 16 Binary signals and 12 analogue channels for internal measurement values. It shall be possible for the Disturbance Recorder function to be triggered by any internal or external binary signal or internal protective function.
    - Comprehensive self-supervision
    - Battery-free memory back-up of Event and Disturbance Records
    - Logic functions (AND, OR, bistable flip flop, etc.)
    - Delay/Integrator function
    - Energy meters to be provided as separated devices

Please see the annexures for examples of a typical signal list for the various bay types. Faults in the bay control IED shall be indicated on a front HMI and a message shall be sent to the station level HMI. The time for fault tracing and replacement of a faulty unit shall be reduced to a minimum.

The supervision shall also cover the power supply system, the internal system bus and the ability of the central processing module to communicate with different printed circuit boards. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

The N-1 criterion shall be maintained in worst case scenarios also. Further, a single failure must not have any effect on the primary system, which is monitored and controlled. Directional overcurrent and earth fault protection is used on all incomers and outgoing feeders.

The IED's switch on to fault (SOTF) function shall be enabled for a minimum period of 200 ms during any close operation of a circuit breaker.

In the event of a breaker failure the bus bar connected to this equipment will be cleared a communication assisted protection solution which is implemented using IEC 61850 GOOSE.

Integrated arc flash sensors shall perform arc flash detection and trip output to the bus bar protection IED in less than 5 ms. A selectable time delay filter is also required (from zero for instantaneous light detection up to 2 s).

The optical light sensors for the arc flash scheme shall be capable of withstanding temperatures above 100°C. On-sensor health indication shall be included for visual verification during maintenance work.

IED time synchronization accurate to 1 ms or better by means of IEEE 1588v2 Power Profile (preferred), IRIG-B or (S)NTP.

Alarms and indications are to be made available to the substation gateway by means of IEC 61850 MMS reports.

Inter-device IED signalling to be achieved by means of IEC 61850 GOOSE messaging.

Local breaker close and trip controls on the IED shall be time-delayed in order to facilitate evacuation of the building prior to operation. Circuit breaker close and trip operations shall also be made available via "Umbilical cord", in order to allow for these operations to be done safely from a distance preferably outside the switching room. MV bay protection will comprise of 1 IED incorporating protection and control functionality. The IEDs will be installed on-board and have integrated arc-flash detection capability.

Dedicated disturbance recording is not required as the IEDs will provide this functionality

### **11 kV Arc-flash busbar protection**

An arc-flash event (with simultaneous current flow through the bay's breaker) in the busbar and circuit breaker chambers shall trigger a bus strip via GOOSE to all bays connected to the same bus bar segment. An arc-flash event in the cable chamber shall only trip the affected bay;

In the event of a breaker failure the connected bus bar segment will be cleared by the GOOSE-based bus protection;

### **11 kV bus section protection**

Overcurrent and earth fault protection is only to be used during energization of a bus bar and/or energizing of the medium voltage equipment; The IED shall be capable of synchronizing when closing the breaker. As such, the IED shall be capable of an additional voltage input to facilitate the sync function.

Switch On To Fault (SOTF) protection is enabled for a minimum period of 200 ms during any breaker close operation. In the event of a breaker failure the bus bar connected to this equipment will be cleared by the GOOSE-based bus protection.

Arc flash protection shall be incorporated in the IED as a standard requirement. Five optical light sensors shall be installed to detect an arc event. The chambers to be monitored are the circuit breaker chamber and the two bus bar chambers for the bus section (and bus riser) switchgear panels.

An arc-flash event with simultaneous current flow in a bus bar chamber shall trigger a bus strip via GOOSE to all panels connected to the same bus bar segment. An arc flash event with simultaneous current flow in the circuit breaker chamber shall trigger a bus strip via GOOSE to all the 11 kV switchgear panels;

### **Low Impedance Differential Protection**

Low Impedance differential protection is only required for Gas Insulated Switchgear (GIS)

applications. Local control at the scheme shall be provided by:

- Zone isolation switches or pushbutton selection
- Breaker failure isolation switches or pushbutton selection

Each bay's current transformer inputs shall be directed to the relay via a current transformer test block.



The test block shall short circuit the current transformer inputs when a test handle or plug is inserted. This action shall not cause any trip.

The scheme shall be equipped with an isolation switch to disable all tripping functionality to bays but still measure all currents for testing and commissioning purposes.

The Breaker failure isolation switch is used to isolate any signals that may cause a low impedance protection operation as a result of testing on a feeder, bus coupler, capacitor bank and transformer incomer bay.

The low impedance differential protection scheme shall accommodate two current transformer measurements per phase for the bus section. These shall be sourced from one current transformer but separate independent and overlapping cores for these bays.

## **Technical Specification of Substation Automation System (SAS)**

### **Scope of Supply**

This specification covers the design, manufacture, inspection, testing at the manufacturer's works and erection and commissioning of a Substation Automation System described in the following sections, to control and operate the 33/11KV AIS substation.

This describes the facilities required to provide the control of plants and systems within a substation and outlines the facilities to be provided on site, interface requirements and performance criteria. The Substation Automation System (SAS) shall comprise full station and bay protection, control, monitoring and communication functions. It shall enable local station control via PC by means of a human machine interface (HMI) and control software package and perform the necessary system control and data acquisition functions. It shall include communication gateway to inter-bay-bus, intelligent electronic devices (IED) for bay control and protection as shown in the enclosed general system architecture drawing.

The communication gateway shall secure control from and information flow to remote network control centers. The inter-bay bus, configured as a star connection (via star couplers) shall provide independent station-to-bay and bay-to-bay data exchange. The bay level intelligent electronic devices (IED) for protection and control shall be directly connected to the instrument transformer without any interposing equipment and perform control, protection, and monitoring functions subject to a detail proposal approved by the Engineer.

The IED's for protection and control functions shall maintain high availability and reliability together with bay independence through extensive self-supervision and state-of-the-art technology. The system shall be capable of having its computing power increased in the future by the addition of additional computing systems.

The system design life shall be not less than 20 years. The Automation system shall be from USA/UK/EU/Canada/Japan/Switzerland.

The bidder shall provide-

- i. IEC 61850 compliance report for the offered system with IEDs
- ii. Interoperability test report for the offered system with ABB, Siemens, Alstom and SEL IEDs with IEC 61850 protocol from any UCA approved system verification and validation center along with the bid document.

The capacity of the SA system shall be sufficient for the ultimate development of the substation as set out in the project requirements.

The SA supplier shall demonstrate that the system proposed has been designed, installed and commissioned in accordance with relevant international standards and the specification shall provide evidence of satisfactory service experience during the past 5 years.

The contractor shall provide the installation software for the substation automation system. Installation, testing and commissioning of substation automation system shall be done by the automation Engineer(s) of the substation automation manufacturer(s).

The software architecture and the database structure shall be finalized with the Purchaser. The facilities shall be incorporated in order to access the database from the backend by the authorized user of the Purchaser. Object-oriented technology shall be used in software development.

The Source Codes of the software standard documentation shall be handed over to the Purchaser. The standard database like Oracle, MySQL, SQL shall be used.

Cyber Security of this system shall be built in with the system. The objective of cyber security is to protect information and physical assets from damage caused by theft, corruption or natural disasters while allowing the information and assets to remain accessible and productive to employers. All potential causes of cyber-attacks need to be considered when employing a defence in depth approach.

### **Compliance With Standards**

For design and type testing of the protection and control equipment, the following standards shall be applicable:

#### **General List of Specifications**

| <b>Specification Code</b> | <b>Description</b>                                                |
|---------------------------|-------------------------------------------------------------------|
| IEC255                    | Electrical                                                        |
| Relays                    |                                                                   |
| IEC60038                  | IEC Standard voltages                                             |
| IEC68068                  | Environmental testing                                             |
| IEC60664                  | Insulation co-ordination for equipment within low-voltage systems |
| IEC61850                  | Standard for Substation integrated protection and control data    |

#### **communication Detailed List of Specifications**

| <b>Specification Code</b> | <b>Description</b>                                                   |
|---------------------------|----------------------------------------------------------------------|
| IEC255-6                  | Measuring relays and protection equipment                            |
| IEC255-7                  | Test and measurement procedures for electromechanical all-or-nothing |
| relays IEC68-2-3          | Test Ca: Damp heat steady state                                      |
| IEC68-2-30                | Test D band guidance; Damp heat, cyclic                              |
| IEC255-5                  | Insulation tests for electrical relays                               |



|                       |                                                                                                                      |
|-----------------------|----------------------------------------------------------------------------------------------------------------------|
| IEC255-22             | Electrical disturbance tests for measuring relays and protection equipment: IEC255-22-1 1 MHz burst disturbance test |
| IEC255-22-2           | Electrostatic discharge test                                                                                         |
| IEC255-22-3           | Radiated electromagnetic field disturbance                                                                           |
| test IEC255-22-4      | Fast transient disturbance test                                                                                      |
| IEC255-11             | Interruptions to and alternating component (ripple) in D.C. auxiliary energizing quantity to measuring relays        |
| IEC255-6              | Measuring relays and protection equipment                                                                            |
| IEC255-21             | Vibration, shock, bump and seismic tests on measuring relays and protection equipment:                               |
| IEC255-21-1           | Vibration tests (sinusoidal)                                                                                         |
| IEC255-21-2           | Shock and bump tests                                                                                                 |
| IEC255-21-3           | Seismic tests                                                                                                        |
| IEC255-0-20           | Contact performance of electrical                                                                                    |
| relays IEC870-3class2 | Digital I/O, Analogue I/O dielectric tests                                                                           |
| IEC801-5/class3       | Digital I/O Surge withstand test                                                                                     |
| IEC870-3/class2       | Radio interference                                                                                                   |
| test IEC801-4/4       | Transient fast burst                                                                                                 |
| test                  |                                                                                                                      |
| IEC801-2/4            | Static discharge                                                                                                     |
| IEC801-3/3            | Electromagnetic fields                                                                                               |

### Design And Operating Requirements

#### (xix) **General**

The SA (Substation Automation) shall be suitable for the operation and monitoring of the complete substation including future extensions. The offered products shall be suitable for efficient and reliable operation and maintenance support of the substations.

The SA system shall be state-of-the art design suitable for operation in high voltage substation environment, follow the latest engineering practice, ensure long term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

Protection is an integral part of the SA system and protective relays shall be directly connected to the interbay bus in order to provide unrestricted access to all data and information stored in the relays and for changing protection parameters from the remote-control location.



Failure behavior of the hardware and software functions shall be addressed and related diagnostic and rectification working instructions shall be provided. The system performance, if failure of communication to main and redundant computer-based workstations, central functions, data model, control and protection IED's, station and bay level communication shall also be clearly addressed (shall be provided by the manufacturer).

The substation can also be controlled by the Local Control Panel. The following modes of operation shall be possible.

Emergency operation of breaker, disconnector, earthing switch etc. from the Local Panel. Emergency operation of breaker, disconnector, earthing switch etc. from the backup mimic panel located in the control room on the 1st floor/Ground floor. Both bay controller guided and unguided operation shall be possible from this panel.

Normal operation of breaker, disconnector, earthing switch etc. from the Station Automation System HMI located in the 1st floor/Ground floor.

The diagram illustrates a network architecture for a school. It features a central server room with two servers, a switch, and a router. The server room is connected to a main switch, which is connected to a distribution switch. The distribution switch is connected to various classrooms and a library. The classrooms are labeled with their respective teachers. The library is labeled 'Library'. The diagram also shows a legend for the components used.

**Legend**

| Symbol | Description |
|--------|-------------|
| [Icon] | Server      |
| [Icon] | Switch      |
| [Icon] | Router      |
| [Icon] | Classroom   |
| [Icon] | Library     |

**Classroom Labels:**

- Classroom 1: Mr. Smith
- Classroom 2: Mrs. Jones
- Classroom 3: Mr. Brown
- Classroom 4: Mrs. White
- Classroom 5: Mr. Green
- Classroom 6: Mrs. Black
- Classroom 7: Mr. Grey
- Classroom 8: Mrs. Pink
- Classroom 9: Mr. Blue
- Classroom 10: Mrs. Yellow
- Classroom 11: Mr. Purple
- Classroom 12: Mrs. Brown
- Classroom 13: Mr. Green
- Classroom 14: Mrs. Black
- Classroom 15: Mr. Grey
- Classroom 16: Mrs. Pink
- Classroom 17: Mr. Blue
- Classroom 18: Mrs. Yellow
- Classroom 19: Mr. Purple
- Classroom 20: Mrs. Brown

**Library Label:**

- Library: Mr. Smith

(xxi) ***Modes Of Operation***

The operator stations and specified remote users shall have the following operational modes, each password protected. Monitoring Ability to select graphic displays and lists for viewing only. No capability to acknowledge alarms, complete controls or select items for inclusion in program functions.

Control: Selection of graphic display and lists. Able to acknowledge station and SA alarms, complete controls, dressing etc. associate with normal real time of the control of the substation.

SA Engineering: Provides all the SA monitoring functions, together with online facilities for program/database/format modifications and checking without the possibility of executing power system controls.

System Manager: Provides access to all system functions, including assignment of passwords and system maintenance activities.

In addition, a facility to provide access to the numerical Protection relays, change / modify relay settings & AVR parameters and Fault Recorder data shall be provided

A series of passwords shall be personally assigned to operators in each of the above categories.

It shall be possible for substation operators to log on to either of the substation workstation and to be allocated the appropriate mode of operation relevant to the password. SA System Engineering work and access to the protection relay and disturbance reorder information shall generally be carried out at the Engineering workstation or remote master station.

All the workstation and the system database shall function as a system. It shall not be necessary for example to acknowledge an alarm at more than one workstation.

Similarly, an operator manual entry applied at a workstation shall be immediately displayed at other workstations where this data is presented.

(xxii) ***Project Specifications***

Specific functions required and boundary conditions of the SA are detailed elsewhere in this specification. The project specific drawings are attached:

- i. Overall single line diagram
- ii. General system architecture
- iii. Location of substation buildings
- iv. Control and operation principles
- v. Protection schemes

(xxiii) ***Vendor's Experience and Local Support***

Only experienced and technically capable manufacturers with minimum 5 years' experience in design and supply of control and protection systems for electricity transmission and distribution utility in Bangladesh applications will be accepted. The preferred manufactures will be those who have experience in deliveries of the full scope of station automation systems and services. This experience has to be substantiated by means of reference installations being in service under similar environmental conditions for at least 5 years. Local assembly or engineering of SAS from Bangladesh is not accepted. All SAS-related design, engineering, and Factory Acceptance Testing (FAT) must be conducted by factory engineers in the EU, USA, Japan, or Canada. Local engineering is not accepted. In order to assess the vendor's experience with similar projects, the vendor is required to submit the following with his Bid:

- i. Technical design specifications and description of SA
- ii. Catalogues and brochures of equipment and devices offered.

- iii. Reference list
- iv. The vendor shall ensure long-term maintenance and availability of spares. Moreover, a guarantee shall be submitted for the availability of spares during the lifetime of the SA equipment (not less than 10 years).

### **General System Design**

The system shall be so designed that personnel without any background in microprocessor-based technology can operate the system easily after they have been provided with some basic training. System control from the substation control room will be with the help of an Industrial Computer (PC) operated by a mouse. The following HMI (Human Machine Interface) functions shall be provided:

- a) Acquisition and plausibility check of switchgear status
- b) Control of switchgear
- c) Remote checking of device parameters and activation of alternative parameter sets in the connected protective relays
- d) Display of actual measured values (U, I, P, Q, f, PF)
- e) Display of Energy (kWh and kVarh export and import)
- f) Display of events
- g) Display of alarms
- h) Display of trends
- i) Sequence control functions
- j) Disturbance records and fault location
- k) System self-supervision
- l) Hard copy printing

Maintenance, modification or extension of components shall not require a shutdown of the whole station automation system. Self-monitoring of single components, modules and communication shall be incorporated to increase the availability of the equipment while minimizing maintenance time to repair.

The data exchange between the electronic devices shall take place via an inter-bay bus using IEC 61850 protocol. The high-speed bus shall permit peer-to-peer communication between the connected devices with democratic access. The entire station shall be controlled and supervised from the station level PC. It shall also be possible to control, monitor and protect each individual bay from the respective bay level equipment for maintenance purposes or if communication to a particular bay should fail. Clear control priorities shall prevent initiation of operation of a single switch at the same time from more than one of the various control levels viz., station level, bay level or switchgear (apparatus) level. The priority shall always be with the lowest enabled control level.

Each bay control and protection unit shall be independent of each other, and its functioning shall not be affected by any fault occurring in any of the other bay control and protection units of the station.

The SAS shall contain the following main functional parts:

- a) Human Machine Interface (HMI) with process database.
- b) Gateway function for remote control via an industrial grade hardware.
- c) Dial in facility/laptop workstation for protection relay parameterization, disturbance analysis and d. SA system fault analysis.
- d) Data exchange between the different system components via high-speed bus.
- e) Bay level devices for control, monitoring and protection.
- f) Bay oriented local control and protection panels with mimic inserts.
- g) Facility for emergency operation of all the switchgear, if bay controller fails. (Key/ master key system.)

The main process information of the station shall be stored in distributed databases. The system shall be based on a de-centralized concept with bay oriented distributed intelligence for safety and availability reasons. Functions shall be decentralized, object oriented and located as close as possible to the process.

The substation monitoring/protection system shall supply data for maintenance, repair and remote parameter setting of protection and control devices in the switchyard.

In the event of a fault in the electrical network, the substation monitoring shall provide a quick means for collecting the relevant and critical data of the fault.

The monitoring system shall be suitable for the supervision and monitoring of all the secondary (IED) and primary devices in a substation including future extensions.

Maintenance, modification or extension of components shall not cause a shut-off of the whole station monitoring system. Self-monitoring of single components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

It shall be possible to access all protection and control devices for reading the terminal parameters (settings). The setting of parameters or activation of parameter sets shall be restricted by password to the protection engineer.

### **Flexibility and Scalability**

The offered SA system concept shall be flexible and shall permit future extensions to be realized easily. Preference will be given to those suppliers who are in a position to provide protection and control devices which can be freely adapted to the application functions required.

### **System Hardware**

#### **Operator Station**

The main operator station shall be based on industrial PC hardware and high-resolution full- graphics screen with manufacturers standard type tested software operating under Windows NT environment. An Event printer and a Hard Copy printer shall be connected via a printer server and LAN to the operator station. The CPU shall be installed in the automation panel.

Dual station computers shall control the SA system and drive the workstations and other peripherals. One of the station computers shall operate the system in the "online" state while the other acts as a "redundant hot standby". The standby computer shall be continuously updated and shall immediately take over the SA system duties without interruption or transfer mechanism should the online operator workstation fail.

Disturbance Records shall be analyzed using the installed Disturbance Record Analysis programs. The Disturbance Records will be collected over the interbay bus, from the connected IED's by the system software. All necessary facilities shall be provided to allow the system to perform spontaneous upload of Disturbance data or upload them in a pre-scheduled manner. The Event printer shall print events spontaneously as they arrive at the main operator station.

Each uploaded data report file shall be reported on one line that shall contain:

- a) The event date and time
- b) The name of the event object
- c) A descriptive text
- d) The state or value of the object

The information fields above shall be structured in columns for maximum readability.

The hard copy printer shall permit printing of any picture (or part thereof) from the station level PC's using easily accessible commands from the window menus.

The main Station PC's shall be supplied by the station DC battery and a UPS system with a supply duration of not less than 30 minutes shall be provided to supply the monitor and the printers.

### **Station Inter-Bay Bus**

The LAN connecting the industrial computer-based operator workstations, printers shall be Ethernet 802.3 LAN, Protocol TCP/IP (10 M.bits/ sec or higher) and the physical medium shall be thin Ethernet or fiber optic bus, provided this LAN is kept within the confines of the control room. The bay control and protection units shall be connected via glass fiber optic cables to a station inter- bay bus, operating on high speed bus, via star couplers. The star coupler shall permit the data exchange between the different system components. Glass Fiber optic connections are used in order to avoid EMI in the switchgear and substation environment.

All protection and control units with serial communication facilities are connected in a star topology via glass fiber optics to the star coupler. Under no circumstances shall events from the protections be taken into the system via bay control unit hardware i.e., each protection device should have its own independent fiber optic communication channel to the star coupler. The star couplers shall be mounted in a separate communication cubicle.

### **Protection And Control IED's on 33kV Level And 11kV level**

The control IED's, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select- before-operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as protection, commands, bay interlocking, data acquisition, data storage and event recording and shall provide inputs for status indication and outputs for commands. They shall be mounted in the LV compartment of the switchgear and shall be directly connected to it without any need for separate interposing equipment or transducers.

The 33 kV bay control & protection IED shall have the following features depending on the requirement:

- a) Minimum of 8 analogue channels
- b) At least 15 binary inputs, 5 signal relays and 2 command relays
- c) 8 nos. programmable LED's on the front of the unit for indication
- d) Instantaneous Phase Overcurrent Protection
- e) Instantaneous Earth Fault Protection
- f) Inverse Time Phase Over Current Protection
- g) Inverse Time Earth Fault Overcurrent Protection
- h) Overvoltage/ under voltage Protection
- i) Synchro check function
- j) Built-in mimic display with controls for operating the switchgear. In the event of failure of the bay unit a backup system for emergency operations should be provided.
- k) High speed bus serial communication port
- l) Sequence of Events Recorder with a buffer for 256 events and a resolution of 1msec. The events that are to be recorded should be freely programmable. These could be alarm/trip signals, external signals connected to optocoupler inputs, internal signals, etc. Once events are defined, they are recorded in chronological order as they occur.

- m) Disturbance Recorder function which can record 9 analogue values, 16 Binary signals and 12 analogue channels for internal measurement values. It shall be possible for the Disturbance Recorder function to be triggered by any internal or external binary signal or internal protective function.
- n) Comprehensive self-supervision
- o) Battery-free memory back-up of Event and Disturbance Records
- p) Logic functions (AND, OR, bistable flip flop, etc.)
- q) Delay/Integrator function

The numerical bay control IED's shall be mounted together with all the relevant bay protective relays in cubicles of Protection Class IP54 or better. Distributed back-up control mimics with associated switches meters and Indicating LED's shall also be provided on these cubicles. These cubicles shall be installed in an air-conditioned room in the substation.

The distributed backup mimic for Local Control shall be installed next to the bay controller IED, which can be used in case of maintenance or emergency or if bay control IED fails. Local bay control via the back-up control mimic on the Control & Protection cubicles shall incorporate the same user safety measures e.g. bay interlocking, synchro check, interlock override user guidance etc. as the station HMI. Local bay control shall be key-locked and the control either from AIS local control panel or station HMI or from remote shall be disabled if the local/remote selector switch on the back up control mimic is in the 'local' position.

The electronic system has to be provided with functions for self-supervision and testing. Each circuit board shall contain circuits for automatic testing of its own function.

Faults in the bay control IED shall be indicated on a front HMI and a message shall be sent to the station level HMI. The time for fault tracing and replacement of a faulty unit shall be reduced to a minimum. The supervision shall also cover the power supply system, the internal system bus and the ability of the central processing module to communicate with different printed circuit boards. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown. The n-1 criteria must be maintained in worst case scenarios also. Further, a single failure must not have any effect on the primary system, which is monitored and controlled.

Only the backup protection can be incorporated in the bay control unit and not the main protection. Main protection shall be provided separately.

All IED's shall have at least 5 years of successful proven experience in HV applications and the MTBF for the offered units shall be provided.

### **Software Structure**

The software package shall be structured according to the SA architecture and strictly divided in various levels. It shall be possible to extend the station with the minimum possible effort. Maintenance, modification or extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

Confirmation that the software programs will be supported for a minimum of 20 years is required to be submitted with the Bid. The licence provided for all kind of software related to SAS must be lifetime duration.

It shall be the responsibility of the contractor to obtain any license required for the operation software. The contractor shall indemnify the client against all claims of infringement of any patent, Registered design, copyright, trademark or trade name or other intellectual property right.

**Station Level Software****Human Machine Interface (HMI)**

The base HMI software package for the operator station shall include the main SA functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements. The System shall contain a library with standard functions and applications.

**Operating System**

Windows operating system shall be used for the operator station as it supports several standard system features, e.g support for several Windows office applications, multitasking, security levels, data exchange mechanisms (DDE, OLE), open data base communication standards (ODBC) and a standardized, user-friendly look & feel HMI. The licensed copy of the operating system backup software shall be provided.

**Bay Level  
Software System  
Software**

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. Its lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage.

**Application Software**

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They shall form part of a library. The application software within the control/protective devices shall be programmed in a functional block language.

**System Testing**

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's, applicable Type Test certificates shall be submitted. FAT should be conducted by concern factory engineer in EU/USA/JAPAN /CANADA. Local engineering is not accepted.

The manufacturing phase of the SA shall be concluded by a Factory Acceptance Test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified with site conditions simulated to the extent possible in a test lab. If the FAT involves only a certain portion of the system for practical reasons, it has to be assured that this test configuration contains at least one unit of each, and every type of equipment incorporated in the delivered system.

If the complete system consists of parts from various suppliers, the supplier shall arrange interoperability test at factory during stage inspection or FAT. The complete system test shall also be performed at site in the Site Acceptance Test (SAT).

**System Functions****Control Unit Functions****CONTROL**

The different high voltage apparatuses within the station shall either be operated manually by the operator or automatically by programmed switching sequences.

The control function shall comprise:



- a) Commands from different operator places, e.g. from the station HMI, or local control panel according to the operating principle
- b) Select before executing commands
- c) Operation from only one operator place at a time.
- d) Operation depending on conditions from other functions, such as interlocking, synchro check, operator mode, or external status conditions.

The control function shall also include:

- a) Prevention of double operation
- b) Command supervision
- c) Selection of operator place
- d) Block/deblock of operation
- e) Block/deblock of updating of position indications
- f) Manual setting of position indications
- g) Overriding of the interlocking function (Second key switch)
- h) Switchgear run time supervision

### **Status Supervision**

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, etc., shall be permanently supervised. Every detected change of position shall be immediately visible on the screen in the single-line diagram, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in cases when spontaneous position changes have taken place.

Each position of an apparatus shall be indicated using two binary auxiliaries normally closed (NC) and normally open (NO) contacts. An alarm shall be initiated if these position indications are inconsistent or indicate an excessive running time of the operating mechanism to change position.

### **Interlocking**

The interlocking function prevents unsafe operation of apparatuses such as isolators and earthing switches within a bay or station wide. The operation of the switchgear shall only be possible when certain conditions are fulfilled. The interlocking function is required to be decentralized so that it does not depend on a central control device. Communication between the various bays for the station interlocking shall take place via bay communication system. An override function shall be provided, which can be enabled to bypass the interlocking function via a key/password, in cases of maintenance or emergency situations.

### **Measurements**

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The correlated values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current

(I) shall be calculated.

### **Event And Alarm Handling**

Events and alarms shall be generated either by the switchgear, by the control devices and by the station level unit. They shall be recorded on an event list in station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time tagged with a time

resolution of 1ms. The time tagging shall be done at the lowest level where the event occurs, and the information shall be distributed with the time tagging.

### **Time Synchronization**

The time within the SA shall be set via a GPS Clock Receiver connected directly to the Bay Level LAN. The time shall then be distributed to the control/protective devices via the high-speed optic fiber bus. An accuracy of  $\pm 1$  ms within the station is required.

### **Synchronism And Energizing Check**

The synchronism and energizing check functions shall be distributed to the control and/or protective devices and shall have the following features:

- a) Adjustable voltage, phase angle, and frequency difference.
- b) Energizing for deadline - live bus, or live line - dead bus
- c) Settings for manual close command and auto-reclose command shall be adaptable to the operating times of the specific switchgear.

### **Voltage Selection**

The voltages, which are relevant for the synchro check functions, depend on the station topology i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, isolator, and earthing switch and shall be selected automatically by the control and protection IED.

### **HMI Functions**

#### **General**

The operator station HMI shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear via the station monitor with the help of mouse clicks on soft keys.

The HMI shall provide the operator with access to alarms and events displayed on the screen. Besides these lists on the screen, there shall be a printout of hard copies of alarms or events in an event log. The Alarm List shall indicate persisting and fleeting alarms separately. An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI:

- a) Single line diagram showing the switching status and measured values.
- b) Control dialogues
- c) Measurement dialogues
- d) Blocking dialogues
- e) Alarm list, station / bay oriented
- f) Event list, station / bay oriented
- g) System status
- h) Checking of parameter settings

### **HMI Design Principles**

Consistent design principles shall be provided with the HMI concerning labels, colors, dialogues and fonts. Non-valid selections shall be dimmed out.

Object status shall be indicated using different status colors for:

- a) Selected object under command
- b) Selected on the screen
- c) Not updated, obsolete value, not in use or not sampled
- d) Alarm or faulty state
- e) Warning or blocked
- f) Update blocked or manually updated
- g) Control blocked
- h) Normal state
- i) Busbar coloring to show live & dead bus

### **Process Status Displays and Command Procedures**

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap changers are displayed in the station single line diagram.

In order to ensure a high degree of security against unwanted operation, a special "select before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognize the selected device on the screen and all other switchgear shall be blocked.

After the "execution" of the command, the operated switch symbol shall blink until the switch has reached its final new position. The system shall permit the operator to execute a command only if the selected object is not blocked and if no interlocking condition is going to be violated the interlocking conditions shall be checked by the interlocking scheme which is implemented on bay level.

After command execution, the operator shall receive confirmation that the new switching position is reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

### **System Supervision Display**

The SA system shall feature comprehensive self-supervision such that faults are immediately indicated to the operator before they possibly develop into serious situations. Such faults are recorded as faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IED's, communication links, and printers at the station level etc.

### **Reports**

The SA shall generate reports that provide time-related information on measured values and calculated values. The data displayed shall comprise:

Trend reports:

- a) Day (mean, peak)
- b) Month (mean, peak)
- c) Semi-annual (mean, peak)
- d) Year (mean, peak)
- e) Historical reports:
  - i. Day
  - ii. Week
  - iii. Month
  - iv. Year

It shall be possible to select displayed values from the database on-line in the process display. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

This report shall be printed automatically at pre-selected times. It shall also be possible to print this report on request.

### **Trend Display (Historical Data)**

A trend is a time-related follow-up of process data. The analogue channels of all the connected bay level devices on the 33 kV level shall be illustrated as trends. The trends shall be displayed in graphical form as columns or curve diagrams with 10 trends per screen as maximum. It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

### **Event List**

The event list shall contain events which are important for the control and monitoring of the substation. The time has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it. A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer. The information shall be obtainable also from printed event log.

The chronological event list shall contain:

- a) Position changes of circuit breakers, isolators and earthing devices.
- b) Indication of protective relay operations
- c) Fault signals from the switchgear
- d) Violation of upper and lower limits of analogue measured value.
- e) Loss of communication

Filters for the selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- a) Date and time.
- b) Bay
- c) Device
- d) Function
- e) Alarm class

### **Alarm List**

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control center. The alarm list shall substitute a conventional alarm tableau and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. Date and time of occurrence shall be indicated. The alarm list consists of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

- a) The alarm date and time
- b) The name of the alarming object
- c) A descriptive text
- d) The acknowledgement state

The operator shall be able to acknowledge alarms, which shall be either audible or only displayed on the monitor. Acknowledged alarms shall be marked on the list. Faults that appear and disappear without being acknowledged shall be specially presented in a separate list for fleeting alarms. For example due to bad

contacts or intermittent operation. Filters for selection of a certain type or group of alarms shall be available as for events.

### Object Picture

When selecting an object such as a circuit breaker or isolator in the single line diagram, first the associated bay picture shall be presented. In the selected object picture, all attributes shall be displayed such as-

- type of blocking,
- authority
- local / remote control
- SA control
- errors, etc.,

### Control Dialogues

The operator shall give commands to the system by means of soft keys located on the single line diagram. It shall also be possible to use the keyboard for soft key activation. Data entry is performed with the keyboard.

### User Authority Levels

It shall be possible to restrict the activation of the process pictures of each object (bays, apparatus, etc.) to a certain user authorization group. Each user shall then be given access rights to each group of objects, e.g.:

- Display only
- Normal operation (e.g. open/close apparatus)
- Restricted operation (e.g. by-passed interlock)
- System administrator

For maintenance and engineering purposes of the station HMI, the following authorization levels shall be available:

- a) No engineering allowed
- b) Engineering/configuration allowed
- c) Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

### System Performance

The refresh/ update times on the operator station PC under normal and calm conditions in the substation shall be according to the levels specified below:

| Functions                                                 | Typical values |
|-----------------------------------------------------------|----------------|
| Exchange of display (first reaction)                      | < 1s           |
| Presentation of a binary change in the process display    | < 0.5 s        |
| Presentation of an analogue change in the process display | < 1s           |
| From order to process output                              | < 0.5 s        |
| From order to update of display                           | < 1.5 s        |

## System Reliability

The SA system shall be designed to satisfy very high demands for reliability and availability concerning:

- 1) Solid mechanical and electrical design
- 2) Security against electrical interference (EMI)
- 3) High quality components and boards
- 4) Modular, well-tested hardware
- 5) Thoroughly developed and tested modular software
- 6) Easy-to-understand programming language for application programming
- 7) Detailed graphical documentation, according to IEC 1131-3, of the application software
- 8) Built-in supervision and diagnostic functions
- 9) After sales service
- 10) Security
- 11) Experience of security requirements
- 12) Process know-how
- 13) Select before execute at operation
- 14) Process at user presentation as double indications
- 15) Distributed solution
- 16) Independent units connected to the local area network
- 17) Back-up functions
- 18) Panel design appropriate to the harsh electrical environment and ambient conditions.
- 19) Panel grounding to provide immunity against transient ground potential rise

## Configuration Tools

The configuration of the station HMI shall be made using the operator station working in a Windows environment. The various functions shall be customized by easy-to-use interactive configuration tools. Configuration shall include the visual presentation of the object, adaptations needed in process database and adaptations of the communication configuration data.

A portable Personal Computer (PC) as a service unit shall be foreseen for on-site modifications of the control and protection devices. The service unit shall be used for documentation, test and commissioning.

The PC based service & support system shall be used for the following purposes:

- System configuration
- System testing
- Help functions
- Program documentation
- Down-and up-loading of programs System commissioning
- Data base management

- Changing peripheral parameters

The service & support system shall be able to monitor data in the running substation control system and to present changing variables on the display screen in graphic representation.

#### **Information Required**

The following documentation shall be provided for the system during the course of the project and they shall be consistent, CAD supported, and of similar look/feel:

- List of Drawings
- Control Room Lay-out
- Assembly Drawing
- Single Line Diagram
- Block Diagram
- Circuit Diagram
- List of Apparatus
- List of Labels
- Functional Design Specification (FDS)
- Test Specification for Factory Acceptance Test (FAT)
- Logic Diagram
- List of Signals
- Manual
- Product Manuals
- Calculation for uninterrupted power supply (UPS) dimensioning
- Licensed Copy of all software
- Third Party cyber security certification

#### **Documentation Required**

The following documents shall be submitted with the offer otherwise the bid will be rejected.

- a) Letter of authorization from the Manufacturers, in case the bidder is not the manufacturer.
- b) Manufacturer's authorization Letter for relay and other protection equipment as mentioned in the technical specification.
- c) Manufacturer's supply record for at least 3 years within the last 10 years specifically mentioning purchaser's name, address, telephone number, fax number, contract number with date, supply quantity with ratings, date of commencement & completion of supply, in format below. Supply record will be equipped with the same offered type of SAS.

| Sl. No. | Name, address, phone & Fax No. of the Consumer | Contract No. & Date | Contract value | Description of materials with quantity | Date of completion of supply |
|---------|------------------------------------------------|---------------------|----------------|----------------------------------------|------------------------------|
|         |                                                |                     |                |                                        |                              |

Satisfactory Performance certificates (SPC) issued within the last 10 years from at least 3 End users depicting that the offered type of automation system.

- d) Submission of Type Test Reports/ Certificate as stated in per relevant IEC from recognized independent laboratories.

## Technical Requirement for Substation Automation System

| DESCRIPTION                                                                                                                                                                                                                        | Unit | BREB's Requirement                                         |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------|--|
| Name & address of the Manufacturer                                                                                                                                                                                                 | -    | To be mentioned                                            |  |
| Country of Origin and Manufacture (Shall be the same)                                                                                                                                                                              | -    | USA/UK/EU/Japan/Germany/Canada/France/Switzerland/Sweden   |  |
| <b>General Requirement:</b>                                                                                                                                                                                                        |      |                                                            |  |
| Communication protocol at all levels                                                                                                                                                                                               | -    | IEC61850. Fully complying with the standard.               |  |
| Temperature range (min/max) Computer                                                                                                                                                                                               | ° C  | 0 to 50                                                    |  |
| Relative humidity                                                                                                                                                                                                                  | %    | 20 to 93 non- condensing                                   |  |
| System performance, interoperability and interchangeability test among ABB(Switzerland/Sweden/Finland)/Hitachi(Switzerland/Sweden)/Siemens (Germany)/ Alstom (France/UK) and SEL(USA) IEDs done in the system verification center. | -    | Yes                                                        |  |
| All updated SCD, ICD and CID files shall be provided in portable hard drives and CD/DVD                                                                                                                                            | -    | YES                                                        |  |
| <b>Detailed Requirements</b>                                                                                                                                                                                                       |      |                                                            |  |
| Manufacturer of the Automation Panel                                                                                                                                                                                               |      | To be mentioned                                            |  |
| Country of Origin & place of manufacture of the Automation Panel                                                                                                                                                                   |      | USA/UK/EU/Japan/Germany/Canada/ France/ Switzerland/Sweden |  |
| The Automation Panel shall be from the origin of the manufacturer of the system                                                                                                                                                    | -    | Yes                                                        |  |
| Name of the Substation Automation System Software                                                                                                                                                                                  | -    | To be mentioned                                            |  |
| Name and Address of the Substation Automation System Software manufacturer                                                                                                                                                         | -    | To be mentioned                                            |  |
| Engineering and Assembling of the substation automation system shall be from the origin of the system                                                                                                                              |      | Yes                                                        |  |



|                                                                                                                                                                                                             |                  |                                                           |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------------------|--|
| Automation equipment Manufacturer's experience                                                                                                                                                              | Year             | 10                                                        |  |
| Number of years of proven field experience of offered system. (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                                                         |  |
| Model of the Substation Automation System                                                                                                                                                                   |                  | To be mentioned                                           |  |
| Design life of Substation Automation System                                                                                                                                                                 | Year             | ≥20                                                       |  |
| Manufacturers quality assurance system                                                                                                                                                                      | -                | ISO 9001/9002 or equivalent                               |  |
| Dimensions of cubicle                                                                                                                                                                                       | mm               | To be mentioned                                           |  |
| Floor load                                                                                                                                                                                                  | N/m <sup>2</sup> | max. 600                                                  |  |
| <b>Station Level Equipment:</b>                                                                                                                                                                             |                  |                                                           |  |
| Station Computer                                                                                                                                                                                            | -                | Industrial PC (From Internationally Reputed Manufacturer) |  |
| Power supply to the servers                                                                                                                                                                                 | -                | 230V AC from Inverter                                     |  |
| Operating System                                                                                                                                                                                            | -                | Windows                                                   |  |
| All standard picture as per Tspec included in HMI                                                                                                                                                           | -                | To be provided                                            |  |
| Process Status Procedures                                                                                                                                                                                   | -                | To be provided                                            |  |
| Event processing as per Tsp Ec                                                                                                                                                                              | -                | To be provided                                            |  |
| Alarm processing as per Tspec                                                                                                                                                                               | -                | To be provided                                            |  |
| Trend Display as per Tspec                                                                                                                                                                                  | -                | To be provided                                            |  |
| User Authority levels as per spec                                                                                                                                                                           | -                | To be provided                                            |  |
| System supervision & monitoring as per Tspec                                                                                                                                                                | -                | To be provided                                            |  |
| Automatic sequence control as per Tspec                                                                                                                                                                     | -                | To be provided                                            |  |
| High quality SCD file complete with ICD files& station topology                                                                                                                                             | -                | To be provided                                            |  |
| Operator Work Station (Master/Backup workstation) shall have separately connection o different Ethernet switch                                                                                              |                  | Yes                                                       |  |
| MTBF (Mean time between Failures)                                                                                                                                                                           | Hrs.             | Shall be mentioned                                        |  |
| MTTR (Mean time to repair)                                                                                                                                                                                  | Hrs.             | Shall be mentioned                                        |  |
| Dual Station Computers Provided in redundant hot standby configuration                                                                                                                                      |                  | YES                                                       |  |
| Number of years of proven field experience of offered software                                                                                                                                              | Yrs.             | 5                                                         |  |
| <b>Gateway to Central Control Room</b>                                                                                                                                                                      |                  |                                                           |  |

|                                                   |   |                                                                      |  |
|---------------------------------------------------|---|----------------------------------------------------------------------|--|
| Name of manufacturer, Address & Country of origin | - | USA/UK/EU/Japan/<br>Germany/Canada/<br>France/Switzerland/<br>Sweden |  |
| Model no.                                         | - | To be provided                                                       |  |





|                                                                                   |      |                                                                      |  |
|-----------------------------------------------------------------------------------|------|----------------------------------------------------------------------|--|
| Number of years of proven field experience of offered unit                        | Year | 5                                                                    |  |
| Insulation tests                                                                  | -    | As per IEC60255-5                                                    |  |
| Fast disturbance tests                                                            | -    | IEC 61000-4-4, Calss 4                                               |  |
| Industrial environment                                                            | -    | EN50081-2ClassA                                                      |  |
| Industrial grade hardware with no moving parts (PC-based gateway is not accepted) | -    | To be provided                                                       |  |
| Design life of offered equipment                                                  | Year | 20                                                                   |  |
| Redundant communication channel                                                   | -    | To be provided                                                       |  |
| Redundant CPU                                                                     | -    | To be provided                                                       |  |
| Redundant DC/DC Supply                                                            | -    | To be provided                                                       |  |
| MTBF (Mean time between Failures)                                                 | Hrs  | To be mentioned                                                      |  |
| MTTR (Mean time to repair)                                                        | Hrs  | To be mentioned                                                      |  |
| <b>Station Bus:</b>                                                               |      |                                                                      |  |
| Connection between Ethernet switches                                              |      | Glass fiber optic                                                    |  |
| Connection between Ethernet switches and IPC, Gateway, Firewall, Printer etc.     |      | Ethernet                                                             |  |
| <b>Inter bay Bus</b>                                                              |      |                                                                      |  |
| Physical Medium                                                                   |      | Glass fiber optic                                                    |  |
| <b>Event Printer</b>                                                              |      |                                                                      |  |
| MTBF                                                                              | Hrs  | To be mentioned                                                      |  |
| <b>Hard Copy Colour Printer</b>                                                   |      |                                                                      |  |
| MTBF                                                                              | Hrs  | To be mentioned                                                      |  |
| <b>Master Clock GPS (Global Positioning System) Receiver:</b>                     |      |                                                                      |  |
| Name of the manufacturer & country of origin                                      | -    | USA/UK/EU/Japan/<br>Germany/Canada/<br>France/<br>Switzerland/Sweden |  |
| Manufacturer's address                                                            | -    | To be mentioned                                                      |  |
| Model                                                                             |      | Shall be mentioned                                                   |  |
| MTBF                                                                              | Hrs. | Shall be mentioned                                                   |  |
| <b>Ethernet Switch</b>                                                            |      |                                                                      |  |
| Name of manufacturer &. address                                                   | -    | USA/UK/EU/Japan/<br>Germany/Canada/<br>France/Switzerland/<br>Sweden |  |
| Model number                                                                      | -    | To be mentioned                                                      |  |
| Type                                                                              |      | Industrial Grade,<br>rackmount                                       |  |
| Redundant Power supply                                                            | -    | To be provided                                                       |  |
| Ethernet switch shall have dual connection to each other.                         |      | Yes                                                                  |  |



|                                    |      |                                                                                       |  |
|------------------------------------|------|---------------------------------------------------------------------------------------|--|
| Communication Port                 |      | Optical with LC connector & Ethernet (Must be compatible with IED Communication Port) |  |
| <b>Operator Work Station (OWS)</b> |      |                                                                                       |  |
| Brand                              | -    | Any International reputed brand.                                                      |  |
| Model                              | -    | To be mentioned                                                                       |  |
| Type                               | -    | Industrial PC                                                                         |  |
| Country of Manufacture             | -    | USA/UK/EU/Japan/<br>Germany/Canada/<br>France/<br>Switzerland/Sweden                  |  |
| Processor                          | GHz  | Intel core i7/ Core Ultra 7 13th generation or latest generation                      |  |
| Clock Speed                        | GHz  | 3.0 GHz (min), 30 MB Cache Memory (min)                                               |  |
| Bus Speed                          | MHz  | Min. 3200 MHz or higher                                                               |  |
| RAM                                | GB   | 16 GB, Expandable to 32 GB (min.)                                                     |  |
| HDD                                | TB   | 2 x 1 TB NVMe SSD (RAID)                                                              |  |
| OS                                 | -    | Licensed windows with Software recovery kit                                           |  |
| Software                           | -    | Lifetime Licensed Anti-Virus Software                                                 |  |
| Mouse                              | -    | Reputed Brand Wireless Optical Mouse                                                  |  |
| Keyboard                           | -    | Integrated standard Keyboard                                                          |  |
| Monitor                            | inch | 15.6", Full HD (min)                                                                  |  |
| Battery                            | -    | Lithium-ion battery                                                                   |  |
| Battery Backup                     | -    | 6 hours or higher with AC Adapter                                                     |  |
| <b>Engineer Work Station (EWS)</b> |      |                                                                                       |  |
| Brand                              | -    | Any International reputed brand.                                                      |  |
| Model                              | -    | To be mentioned                                                                       |  |
| Country of Origin                  | -    | USA/UK/EU/Japan/<br>Germany/Canada/ France/<br>Switzerland/Sweden                     |  |
| Processor                          | GHz  | Intel Core i5 Processor, 13th generation or latest                                    |  |
| Clock Speed                        | GHz  | 3.0 GHz (min), 20MB Cache Memory (min)                                                |  |
| Bus Speed                          | MHz  | Min. 3200 MHz or higher                                                               |  |
| RAM                                | GB   | 16 GB DDR4                                                                            |  |
| HDD                                | GB   | 1 TB NVMe SSD                                                                         |  |

|                |      |                                                                                                                                         |  |
|----------------|------|-----------------------------------------------------------------------------------------------------------------------------------------|--|
| Mouse          | -    | Reputed Brand Wireless Optical Mouse                                                                                                    |  |
| Keyboard       | -    | Integrated standard Keyboard                                                                                                            |  |
| Monitor        | inch | 15.6", Full HD (min)                                                                                                                    |  |
| Battery        | -    | Lithium-ion battery                                                                                                                     |  |
| Battery Backup | -    | 6 hours or higher with AC Adapter                                                                                                       |  |
| OS Support     | -    | Windows 11 professional or latest                                                                                                       |  |
| OS             | -    | License windows with recovery kit                                                                                                       |  |
| Software       |      | All types of configuration software with licenses for SAS and IED, Licensed Anti-Virus Software, Licensed OS & other necessary software |  |





|                                                           |     |                                                                                                                      |
|-----------------------------------------------------------|-----|----------------------------------------------------------------------------------------------------------------------|
| <b>Laser Color Printer</b>                                |     |                                                                                                                      |
| Brand                                                     | -   | Any International reputed brand.                                                                                     |
| Model                                                     | -   | To be mentioned                                                                                                      |
| Country of origin                                         | -   | To be mentioned                                                                                                      |
| Toner type                                                | -   | Toner and associated drum unit in single case, No starter toner. output tray, 250-sheet facedown output tray purpose |
| Media Sizes                                               | -   | Letter, Legal, A4, A5, B5 and custom sizes                                                                           |
| Media Types                                               | -   | Paper (Plain, Preprinted, Letterhead, Bond, Paper (Plain Color, Recycled, Rough), Transparencies, Labels             |
| <b>Event Printer</b>                                      |     |                                                                                                                      |
| Brand                                                     | -   | Any International reputed brand.                                                                                     |
| Model                                                     | -   | To be mentioned                                                                                                      |
| Country of origin                                         | -   | To be mentioned                                                                                                      |
| Print Method                                              | Pin | 9 Pin Serial Impact Dot Matrix.                                                                                      |
| Print Speed                                               | Lps | Min. 6.0 LPS (30 Columns:16 CPI).                                                                                    |
| Data Buffer                                               | KB  | 4KB.                                                                                                                 |
| Inked Ribbon                                              | -   | ERC-38(Black/Red).                                                                                                   |
| Interface                                                 | -   | USB Interface, Bi- directional parallel.                                                                             |
| <b>System Performance:</b>                                |     |                                                                                                                      |
| Exchange of display (First reaction)                      | Sec | <1                                                                                                                   |
| Presentation of a binary change in the Process display    | Sec | < 0.5                                                                                                                |
| Presentation of an analogue change in the process display | Sec | <1                                                                                                                   |
| From order to process output                              | Sec | < 0.5                                                                                                                |
| From order to updated of display                          | Sec | < 1.5                                                                                                                |
| <b>Protocol Converter / IO module, if required</b>        |     |                                                                                                                      |
| Brand                                                     | -   | To be mentioned                                                                                                      |
| Model                                                     | -   | To be mentioned                                                                                                      |
| Country of Manufacturer                                   | -   | USA/UK/EU/Japan/ Germany/Canada/ France/ Switzerland/Sweden                                                          |
| Detail Signaling & Interlocking system                    |     | To be included                                                                                                       |
| <b>Firewall</b>                                           |     |                                                                                                                      |
| Name of Manufacturer                                      |     | To be mentioned                                                                                                      |

|                                                                                                                                                                          |  |                                                                      |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------|--|
| Brand                                                                                                                                                                    |  | To be mentioned                                                      |  |
| Model/Type                                                                                                                                                               |  | To be mentioned                                                      |  |
| Origin                                                                                                                                                                   |  | USA/UK/EU/Japan/<br>Germany/Canada/<br>France/<br>Switzerland/Sweden |  |
| IP Filtering Port Filtering MAC<br>Filtering Port Forwarding DMZ<br>Denial of Service NAT Mapping                                                                        |  | To be provided                                                       |  |
| Packet throughput of at least 150<br>Mbps                                                                                                                                |  | To be mentioned                                                      |  |
| 3DES Encryption throughput of 20<br>Mbps                                                                                                                                 |  | To be mentioned                                                      |  |
| Support for 200 VPNs                                                                                                                                                     |  | To be mentioned                                                      |  |
| Maximum concurrent sessions,<br>with AVC                                                                                                                                 |  | To be mentioned                                                      |  |
| Maximum new connections per<br>second, with AVC                                                                                                                          |  | To be mentioned                                                      |  |
| Local On-device Management                                                                                                                                               |  | Yes                                                                  |  |
| Application Visibility and Control<br>(AVC)                                                                                                                              |  | Standard                                                             |  |
| Security Intelligence                                                                                                                                                    |  | Standard, with IP, URL, and<br>DNS threat<br>intelligence            |  |
| List (Name & version) of all types<br>of software required for SAS<br>configuration, operation,<br>monitoring and Remote control<br>individually<br>for Both OWS and EWS |  | To be mentioned                                                      |  |
| <b>Others Requirement</b>                                                                                                                                                |  |                                                                      |  |
| All Licenses required for the<br>system including future SCADA<br>connection with physical<br>communication port ready installed                                         |  | To be provided as per<br>requirement of<br>employer                  |  |
| The Communication device shall<br>support for future SCADA<br>connection                                                                                                 |  | IEC 60870-5-104                                                      |  |
| Facility for measuring SAIDI SAIFI                                                                                                                                       |  | To be included                                                       |  |
| The licence provided for all kind of software related to SAS must be lifetime<br>duration.                                                                               |  |                                                                      |  |

### 1.3 Documentation

The following documents/sample(s), but not limited to, must be submitted along with the Bid:

- i) Printed Catalogues with detailed technical information of each offered item.
- ii) 33 kV GIS Circuit Breaker and 11kV switchgear constructional diagram and dimensions.
- iii) 33 kV Relay and Control Panel constructional diagram and dimensions.
- iv) 33 kV and 11 kV Power Cable and Accessories constructional diagram and dimensions.
- v) Type Test Reports on 33/11.55kV, 10/14 MVA Power Transformer, 33 kV GIS Switchgear, 11kV AIS switchgear, 11 kV power cable and power cable accessories shall have to be submitted with Bid. Type Test Report shall be submitted from the internationally recognized Independent Testing Laboratories or the Testing Laboratories as stated in the technical specification as per the standard stated in the

technical specification.



- vi) ISO Certification on manufacturing process.
- vii) All data schedules duly filled up with appropriate technical data.
- viii) other documents as mentioned in any section of the bidding documents & also as required of Employer.

## **1.4 ADDITIONAL WORKS**

Any additional works not covered above but necessary for the functioning of the system & required as per specification incorporated. The items of minor nature, which is not mentioned, shall be incorporated by the bidder.

## **1.5 APPROVAL OF DRAWINGS**

The successful Bidder shall submit five (5) sets of Drawings and other technical information of the offered goods to the office of the Project Manager within thirty (30) days from the date of signing of the contract agreement, for approval.

No work shall be performed in connection with the fabrication and manufacture of the offered goods until the drawings and technical data have been approved. The cost of supplying drawing shall be borne by the supplier.

## **1.5 TRAINING OF TECHNOLOGY TRANSFER & TECHNICAL KNOW-HOW COURSE (OVERSEAS) OF BREB'S ENGINEERS**

- (a) **Local Training:** The Contractor shall provide Local Technical Training for 7 days for 4 Nos. technical Personnel of BREB/PBS for each S/S on operation, maintenance, protection & control and also trouble shooting of 33/11 kV S/S. Printed training manual & required documents and foods & training allowance as per govt. rules must be provided.
- (b) **Foreign Training:** The Contractor shall provide foreign training (In Manufacturer premises) for 7 days for 5 technical personnel of BREB/PBS on operation, maintenance, protection & control and also trouble shooting of GIS breaker. Printed training manual & required documents, all costs including visa fees, air fares, accommodation, fooding, laundry, transportation etc. plus daily allowance (not less than govt. rules) and any logistics support as required must be provided.

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**Cable Termination Tools**

| Sl. No. | Description                                                                                                    | Unit | Employer's Requirement                                                                                                                                                                                      | Manufacturer's Guaranteed Particulars |
|---------|----------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1       | Manufacturer's Name                                                                                            |      | To be mentioned                                                                                                                                                                                             |                                       |
| 2       | Country of Origin                                                                                              |      | UK, Germany, USA, Japan / Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                                       |
| 3       | Manufacturer's Model No                                                                                        |      | To be mentioned                                                                                                                                                                                             |                                       |
| 4       | The Tools set shall include                                                                                    |      |                                                                                                                                                                                                             |                                       |
| i       | Hydraulic Hand-Operated Compression Tool                                                                       |      | Shall be provided                                                                                                                                                                                           |                                       |
| ii      | Compression Hand with pull-off die for size 3                                                                  |      |                                                                                                                                                                                                             |                                       |
| iii     | Impact Devices                                                                                                 |      |                                                                                                                                                                                                             |                                       |
| iv      | Measuring Template for size 3                                                                                  |      |                                                                                                                                                                                                             |                                       |
| v       | Hexagon Wrench                                                                                                 |      |                                                                                                                                                                                                             |                                       |
| vi      | Chain for suspending the assembly lever and hole bar                                                           |      |                                                                                                                                                                                                             |                                       |
| vii     | Assembly Lever for pressing and releasing the bell flange of the CONNEX separable connector Size 3             |      |                                                                                                                                                                                                             |                                       |
| viii    | Unplug Rod for Assembly Lever for size 3                                                                       |      |                                                                                                                                                                                                             |                                       |
| ix      | Hole Bar for suspending the assembly Lever                                                                     |      |                                                                                                                                                                                                             |                                       |
| x       | Assembly Clamp for holding the cable during heat-shrinking and radial cutting with adjustable depth stop.      |      |                                                                                                                                                                                                             |                                       |
| xi      | Cable Stripper with spare blade for XLPE insulation longitudinal and radial cutting with adjustable depth stop |      |                                                                                                                                                                                                             |                                       |
| xii     | Hard carrying case                                                                                             |      |                                                                                                                                                                                                             |                                       |
| 4       | Printed catalogues shall furnish with identifying by indelible ink                                             |      | Shall be provided                                                                                                                                                                                           |                                       |
| 5       | All accessories                                                                                                |      | Shall be provided                                                                                                                                                                                           |                                       |



**Seal & Signature of the bidder**

**Seal & Signature of the Manufacturer**



**GIS Installation Tools**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

Bidder shall provide the list of the offered tools with quantity as well as Manufacturer's guaranteed Particulars with Printed catalogues along with the bid. Please note that, GIS Installation Tools shall be compatible for using in the plant & the country of origin of the tools will UK, Germany, USA, Japan / Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer)

**Seal & Signature of the bidder**

**Seal & Signature of the Manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**Test Plug for GIS**

| Sl. No. | Description                                                           | Unit | Employer's Requirement                                                                                                                                                                                                                            | Manufacturer's guaranteed Particulars |
|---------|-----------------------------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1       | Manufacturer's Name                                                   |      | To be mentioned                                                                                                                                                                                                                                   |                                       |
| 2       | Country of Origin                                                     |      | UK, Germany ,<br>USA, Japan / Other<br>eligible countries<br>may be accepted<br>where equivalent<br>quality (Please see<br>the<br>instruction, Section-<br>3) can be<br>demonstrated<br>(Acceptance of<br>equivalency will<br>depend on Employer) |                                       |
| 3       | Manufacturer's Model No                                               |      | To be mentioned                                                                                                                                                                                                                                   |                                       |
| 4       | Size                                                                  |      | 3                                                                                                                                                                                                                                                 |                                       |
| 5       | Total length                                                          | M    | 1.6                                                                                                                                                                                                                                               |                                       |
| 6       | Cable Type                                                            |      | Flexible                                                                                                                                                                                                                                          |                                       |
| 7       | Maximum operating voltage<br>AC                                       | kV   | 42                                                                                                                                                                                                                                                |                                       |
| 8       | Nominal current                                                       | A    | ≥400                                                                                                                                                                                                                                              |                                       |
|         | Length of the screen wire                                             | mm   | ≥300                                                                                                                                                                                                                                              |                                       |
| 9       | Rated PF withstand voltage                                            | kV   | ≥95                                                                                                                                                                                                                                               |                                       |
| 10      | Rated LI withstand voltage                                            | kV   | ≥200                                                                                                                                                                                                                                              |                                       |
| 11      | Printed catalogues shall<br>furnish<br>with identify by indelible ink |      | Shall be provided                                                                                                                                                                                                                                 |                                       |
| 12      | All accessories                                                       |      | Shall be provided                                                                                                                                                                                                                                 |                                       |

**Seal & Signature of the bidder****Seal & Signature of the Manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**SF6 Gas Filling Kit**

| Sl. No. | Description                | Unit     | Employer's Requirement                                                                                                                                                                                      | Manufacturer's guaranteed Particulars |
|---------|----------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1       | Manufacturer's Name        |          | To be mentioned                                                                                                                                                                                             |                                       |
| 2       | Country of Origin          |          | UK, Germany, USA, Japan / Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                                       |
| 3       | Manufacturer's Model No    | mm       | To be mentioned                                                                                                                                                                                             |                                       |
| 4       | Equipment Type             | kg       | To be mentioned                                                                                                                                                                                             |                                       |
| 5       | SF6 storage Capacity       | Liter    | 300                                                                                                                                                                                                         |                                       |
| 6       | Compressor Capacity        | Bar      | <50                                                                                                                                                                                                         |                                       |
| 7       | Vacuum Compressor Capacity | mili bar | <50 mbar                                                                                                                                                                                                    |                                       |
| 8       | Vacuum Pump Capacity       | mili bar | <1 mbar                                                                                                                                                                                                     |                                       |
| 9       | Evaporator                 |          | To be mention                                                                                                                                                                                               |                                       |
| 10      | Dry Filter                 |          | To be mention                                                                                                                                                                                               |                                       |
| 11      | Particle Filter            |          | To be mention                                                                                                                                                                                               |                                       |
| 12      | Connecting Hose Length     |          | To be mention                                                                                                                                                                                               |                                       |
| 13      | Indicating Instruments     |          | To be mention                                                                                                                                                                                               |                                       |
| 14      | Dimension                  |          | To be mention                                                                                                                                                                                               |                                       |
| 15      | Weight                     | kg.      | To be mention                                                                                                                                                                                               |                                       |

**Seal & Signature of the bidder****Seal & Signature of the Manufacturer**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**FOR SF6 GAS DUE POINT TEST SET**

| Sl. No. | Description                     | Unit | BREB Requirement                                                                                                                                                                             | Manufacturer's Guaranteed Particulars |
|---------|---------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1       | Manufacturer's Name and address |      | Dilo/ Other eligible Manufacturer's may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                                       |
| 2       | Country of Origin               |      | Germany/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer)   |                                       |
| 3       | Manufacture's model no.         |      | To be mentioned                                                                                                                                                                              |                                       |
| 5       | Equipment Type                  |      | SF6 Gas Due Point Test Set                                                                                                                                                                   |                                       |
| 6       | Operating voltage               |      | 100-240 VAC, 50 Hz                                                                                                                                                                           |                                       |
| 7       | Measuring range                 |      | -60 to +10 °C (due point)                                                                                                                                                                    |                                       |
| 8       | Measuring accuracy              |      | To be mentioned                                                                                                                                                                              |                                       |
| 9       | Input pressure                  |      | to be mentioned                                                                                                                                                                              |                                       |
| 10      | Operating temperature           |      | -10 to +50 °C                                                                                                                                                                                |                                       |
| 11      | Ambient moisture                |      | up to 90 % relative moisture, non-condensing during operation                                                                                                                                |                                       |
| 12      | Dimension                       |      | To be mentioned                                                                                                                                                                              |                                       |
| 13      | Weight                          | Kg   | To be mentioned                                                                                                                                                                              |                                       |
| 14      | Accessories to be supplied      |      | To be mentioned                                                                                                                                                                              |                                       |

\_\_\_\_\_  
**Seal & Signature of the Bidder  
the Manufacturer**

\_\_\_\_\_  
**Seal & Signature of**

**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**FOR SF6 GAS PURITY TEST SET**

| Sl. No. | Description             | Unit | BREB Requirement                                                                                                                                                                              | Manufacturer's Guaranteed Particulars |
|---------|-------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1       | Manufacturer's Name     |      | Dilo / Other eligible Manufacturer's may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                                       |
| 2       | Country of Origin       |      | Germany/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer)    |                                       |
| 3       | Manufacture's model no. |      | To be mentioned                                                                                                                                                                               |                                       |
| 5       | Equipment Type          |      | SF6 Gas Purity Test Set                                                                                                                                                                       |                                       |
| 6       | Input Pressure          | Bar  | To be mentioned                                                                                                                                                                               |                                       |
| 7       | Power Supply            | Volt | 100-240 V                                                                                                                                                                                     |                                       |
| 8       | Power Frequency         | Hz   | 50 Hz                                                                                                                                                                                         |                                       |
| 9       | Operating Temperature   | C    | -10 °C to +50°C                                                                                                                                                                               |                                       |
| 10      | Purity Specification:   |      |                                                                                                                                                                                               |                                       |
|         | Measuring Range         |      | SF6 concentration [%]: 0 to 100%                                                                                                                                                              |                                       |
|         | Accuracy                |      | To be mentioned                                                                                                                                                                               |                                       |
|         | Response Time           |      | To be mentioned                                                                                                                                                                               |                                       |
| 11      | Flow Rate               |      | To be mentioned                                                                                                                                                                               |                                       |
|         | Moisture Specification  |      |                                                                                                                                                                                               |                                       |
|         | Measuring Range         |      | -60 <sup>0</sup> c to 10 <sup>0</sup> c                                                                                                                                                       |                                       |
|         | Display                 |      | LCD                                                                                                                                                                                           |                                       |
|         | Accuracy                |      | To be mentioned                                                                                                                                                                               |                                       |
| 12      | Response Time           |      | To be mentioned                                                                                                                                                                               |                                       |
|         | Flow Rate               |      | To be mentioned                                                                                                                                                                               |                                       |
| 12      | Communication Port      |      | USB                                                                                                                                                                                           |                                       |
| 13      | Dimension               |      | To be mentioned                                                                                                                                                                               |                                       |
| 15      | Weight                  | Kg   | To be mentioned                                                                                                                                                                               |                                       |

\_\_\_\_\_  
**Seal & Signature of the Bidder  
the Manufacturer**

\_\_\_\_\_  
**Seal & Signature of**





**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**FOR SF6 GAS LEAK DETECTOR**

| Sl. No. | Description                                          | Unit      | BREB Requirement                                                                                                                                                                             | Manufacturer's Guaranteed Particulars |
|---------|------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1       | Manufacturer's Name                                  |           | Dilo/ Other eligible Manufacturer's may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                                       |
| 2       | Country of Origin                                    |           | Germany/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer)   |                                       |
| 3       | Manufacture's model no.                              |           | To be mentioned                                                                                                                                                                              |                                       |
| 4       | Equipment Type                                       |           | SF6 Gas leak detector                                                                                                                                                                        |                                       |
| 5       | Sensitivity                                          |           | 5 g SF6/year or less                                                                                                                                                                         |                                       |
| 6       | Operating Temperature                                |           | 0 °C to 50°C                                                                                                                                                                                 |                                       |
| 7       | Battery life                                         |           | Approx.30 hours                                                                                                                                                                              |                                       |
| 8       | Method of Operation                                  |           | Continuous operation without limitation                                                                                                                                                      |                                       |
| 9       | Response Time                                        |           | immediately                                                                                                                                                                                  |                                       |
| 10      | Reset Time                                           |           | To be mentioned                                                                                                                                                                              |                                       |
| 11      | Warm up time                                         |           | To be mentioned                                                                                                                                                                              |                                       |
| 12      | Fixed Sensor Length                                  |           | To be mentioned                                                                                                                                                                              |                                       |
| 13      | Dimension                                            |           | To be mentioned                                                                                                                                                                              |                                       |
| 14      | Weight                                               | <b>Kg</b> | To be mentioned                                                                                                                                                                              |                                       |
| 15      | Accessories to be supplied                           |           | To be mentioned                                                                                                                                                                              |                                       |
| 16      | Manufacturer's Original Printed Catalogue in English |           | To be provided                                                                                                                                                                               |                                       |

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**Seal & Signature of the Bidder  
the Manufacturer**
**Seal & Signature of**
**TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE**

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data and provide all of the information requested, then to be sealed & signed by both Bidder & manufacturer, otherwise the Bid will be treated as non-responsive)

**GTP of SF6 GAS RECOVERY & REFILLING DEVICE**

| <b>Sl<br/>No</b> | <b>Description</b>               | <b>Unit</b> | <b>Employer<br/>Requirement</b>                                                                                                                                                              | <b>Manufacturer's<br/>guaranteed<br/>Particulars</b> |
|------------------|----------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| 1                | Manufacturer's Name              | -           | Dilo/ Other eligible Manufacturer's may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                                                      |
| 2                | Country of Manufacture           |             | Germany/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer)   |                                                      |
| 3                | Manufacture's model no.          | -           | To be mentioned                                                                                                                                                                              |                                                      |
| 4                | Equipment Type                   | -           | To be mentioned                                                                                                                                                                              |                                                      |
| 5                | Application and feature          |             | SF6 maintenance device being equipped with compressors and operating entirely without oil and suction pumps for reclaiming SF6 down to 1 mbar having feature of Gas recovery and refilling   |                                                      |
| 6                | SF <sub>6</sub> Storage Capacity | Litre       | 300                                                                                                                                                                                          |                                                      |
| 7                | Compressor Capacity              | Bar         | >50                                                                                                                                                                                          |                                                      |
| 8                | Vacuum Compressor Capacity       | mili<br>Bar | To be mentioned                                                                                                                                                                              |                                                      |
| 9                | Vacuum Pump Capacity             | mili<br>Bar | To be mentioned                                                                                                                                                                              |                                                      |
| 10               | Evaporator                       |             | To be mentioned                                                                                                                                                                              |                                                      |
| 11               | Dry Filter                       |             | To be mentioned                                                                                                                                                                              |                                                      |
| 12               | Particle Filter                  |             | To be mentioned                                                                                                                                                                              |                                                      |
| 13               | Connecting Hose Length           |             | To be mentioned                                                                                                                                                                              |                                                      |
| 14               | Indicating Instruments           |             | To be mentioned                                                                                                                                                                              |                                                      |

| <b>SI<br/>N<br/>o</b> | <b>Description</b> | <b>Unit</b> | <b>Employer<br/>Requirement</b> | <b>Manufacturer's<br/>guarantee<br/>d<br/>Particular<br/>s</b> |
|-----------------------|--------------------|-------------|---------------------------------|----------------------------------------------------------------|
| 15                    | Dimension          |             | To be mentioned                 |                                                                |
| 16                    | Weight             | Kg          | To be mentioned                 |                                                                |

**Seal & Signature of the Bidder  
the Manufacturer**

**Seal & Signature of**

CCTV system

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data)

**Contractor shall supply and install CCTV system with 06 IP cameras and necessary accessories required for fitting & fixing up to commissioning. CCTV must be in suitable for place. Contractor shall fulfill the requirement of following technical specification of CCTV and instruction of Engineer in charge / Employer.**

| <b>Description</b>                      | <b>Employer Requirement</b>                         | <b>Manufacturer's<br/>guaranteed<br/>Particulars</b> |
|-----------------------------------------|-----------------------------------------------------|------------------------------------------------------|
| <b>4 MP Fixed Bullet Network Camera</b> |                                                     |                                                      |
| Brand                                   | To Be Mentioned By Bidder                           |                                                      |
| Model                                   | To Be Mentioned By Bidder                           |                                                      |
| Country of Origin                       | To Be Mentioned By Bidder                           |                                                      |
| Country of Manufacturer                 | To Be Mentioned By Bidder                           |                                                      |
| <b>Technical Specification</b>          |                                                     |                                                      |
| Image Sensor                            | 1/3" Progressive Scan CMOS                          |                                                      |
| Min. Illumination                       | Color: 0.003 Lux @ (F1.4, AGC ON)                   |                                                      |
| Wide Dynamic Range                      | 120 dB                                              |                                                      |
| Day & Night                             | ICR Cut                                             |                                                      |
| Lens Mount                              | M12                                                 |                                                      |
| IR Range                                | Up to 60 m                                          |                                                      |
| IR Wavelength                           | Maximum 850 nm                                      |                                                      |
| Visual Alarm                            | Yes                                                 |                                                      |
| Resolution                              | Minimum 2688 × 1520                                 |                                                      |
| Video Bit Rate                          | 128 Kbps to 8 Mbps                                  |                                                      |
| H.265 Type                              | Main Profile                                        |                                                      |
| Bit Rate Control                        | CBR/VBR                                             |                                                      |
| Region of Interest (ROI)                | 1 fixed region for main stream and sub-stream       |                                                      |
| Environment Noise Filtering             | Yes                                                 |                                                      |
| Audio Sampling Rate                     | 8 kHz/16 kHz/32 kHz/44.1 kHz/48 kHz                 |                                                      |
| Audio Compression                       | G.711ulaw/G.711alaw/G.722.1/G.726/MP2L2/PCM/MP3/AAC |                                                      |

| Description                      | Employer Requirement                                                                                                                                                                                                             | Manufacturer's guaranteed Particulars |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Audio Bit Rate                   | 64 Kbps (G.711ulaw/G.711alaw)/16 Kbps (G.722.1)/16 Kbps (G.726)/32 to 192 Kbps (MP2L2)/8 to 320 Kbps (MP3)/16 to 64 Kbps (AAC)                                                                                                   |                                       |
|                                  |                                                                                                                                                                                                                                  |                                       |
| Simultaneous Live View           | Up to 6 channels                                                                                                                                                                                                                 |                                       |
| API                              | Open Network Video Interface (PROFILE S, PROFILE G, PROFILE T), ISAPI, SDK                                                                                                                                                       |                                       |
| User/Host                        | Up to 32 users. 3 user levels: administrator, operator and user                                                                                                                                                                  |                                       |
| Security                         | Password protection, complicated password, HTTPS encryption, IP address filter, Security Audit Log, basic and digest authentication for HTTP/HTTPS, TLS 1.1/1.2, WSSE and digest authentication for Open Network Video Interface |                                       |
|                                  |                                                                                                                                                                                                                                  |                                       |
| Network Storage                  | MicroSD/SDHC/SDXC card (Minimum 256 GB) local storage, and NAS (NFS, SMB/CIFS), auto network replenishment (ANR)                                                                                                                 |                                       |
|                                  | detection are supported                                                                                                                                                                                                          |                                       |
| Image Enhancement                | BLC, HLC, 3D DNR                                                                                                                                                                                                                 |                                       |
| Image Parameters Switch          | Yes                                                                                                                                                                                                                              |                                       |
| Image Settings                   | Rotate mode, saturation, brightness, contrast, sharpness, gain, white balance adjustable by client software or web browser                                                                                                       |                                       |
|                                  |                                                                                                                                                                                                                                  |                                       |
| Ethernet Interface               | 1 RJ45 10 M/100 M self-adaptive Ethernet port                                                                                                                                                                                    |                                       |
| Basic Event                      | Motion detection (human and vehicle targets classification), video tampering alarm, exception                                                                                                                                    |                                       |
| Perimeter Protection             | Line crossing detection, intrusion detection, region entrance detection, region exiting detection                                                                                                                                |                                       |
| Linkage Method                   | Upload to NAS/memory card/FTP, notify surveillance center, trigger record, trigger capture, send email.                                                                                                                          |                                       |
| Startup and Operating Conditions | -30 °C to 60 °C (-22 °F to 140 °F), humidity 95% or less (non-condensing)                                                                                                                                                        |                                       |

|                               |                                                           |  |
|-------------------------------|-----------------------------------------------------------|--|
| Power Supply                  | 12 VDC $\pm$ 25%; PoE: 802.3af, Class3                    |  |
| Power Consumption and Current | 12 V, 0.88 A, (N/A) max: 10.5 W                           |  |
|                               | PoE: (802.3af, 36 V to 57 V), 0.34 A to 0.21 A, max: 12 W |  |
| Camera Material               | Aluminum alloy body                                       |  |



| Description                     | Employer Requirement                                                                                                             | Manufacturer's guaranteed Particulars |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| EMC                             | FCC (47 CFR Part 15, Subpart B); CE-EMC<br>(EN 55032: 2015, EN 61000-3-2: 2014, EN 61000-3-3: 2013, EN 50130-4: 2011 +A1: 2014); |                                       |
|                                 | KC (KN 32: 2015, KN 35: 2015)                                                                                                    |                                       |
|                                 |                                                                                                                                  |                                       |
| Safety                          | UL (UL 60950-1);                                                                                                                 |                                       |
|                                 | CE-LVD (EN 60950-1: 2005 + Am 1: 2009 + Am 2: 2013)                                                                              |                                       |
| Environment                     | CE-RoHS (2011/65/EU); WEEE (2012/19/EU); Reach (Regulation (EC) No 1907/2006)                                                    |                                       |
| Protection                      | IP67 (IEC 60529-2013)                                                                                                            |                                       |
| Surge Protection                | 4KV                                                                                                                              |                                       |
| <b>4 MP Network Dome Camera</b> |                                                                                                                                  |                                       |
| <b>Descriptions</b>             | <b>Minimum Required Specification</b>                                                                                            |                                       |
| Brand                           | To Be Mentioned By Bidder                                                                                                        |                                       |
| Model                           | To Be Mentioned By Bidder                                                                                                        |                                       |
| Country of Origin               | To Be Mentioned By Bidder                                                                                                        |                                       |
| Country of Manufacturer         | To Be Mentioned By Bidder                                                                                                        |                                       |
| <b>Technical Specification</b>  |                                                                                                                                  |                                       |
| Image Sensor                    | 1/1.8" Progressive Scan CMOS                                                                                                     |                                       |
| Illumination                    | Min. 0.0005 Lux @ (F1.0, AGC ON), 0 Lux with Light                                                                               |                                       |
| Wide Dynamic Range              | Min. 130 dB                                                                                                                      |                                       |
| Depth of Focus                  | Maximum 2.8 mm, 2.5 m to $\infty$ 4 mm                                                                                           |                                       |
| Lens Mount                      | M16                                                                                                                              |                                       |
| White Light Range               | 30 m                                                                                                                             |                                       |
| Smart Supplement Light          | Yes                                                                                                                              |                                       |
| Resolution                      | Min. 2688 × 1520                                                                                                                 |                                       |
| Video Compression               | Main Stream: H.265/H.264/H.265+/H.264+<br>Sub-Stream: H.265/H.264/MJPEG                                                          |                                       |
|                                 | Third Stream: H.265/H.264                                                                                                        |                                       |
| Video Bit Rate                  | 128 Kbps to 8 Mbps                                                                                                               |                                       |
| Bit Rate Control                | CBR/VBR                                                                                                                          |                                       |
| Region of Interest (ROI)        | 1 fixed region for main stream and sub-stream                                                                                    |                                       |
| Environment Noise Filtering     | Yes                                                                                                                              |                                       |
| Audio Sampling Rate             | 8 kHz/16 kHz/32 kHz/44.1 kHz/48 kHz                                                                                              |                                       |
| Audio Compression               | G.711ulaw/G.711alaw/G.722.1/G.726/MP2L2/PCM/MP3/AAC                                                                              |                                       |
| Audio Bit Rate                  | 64 Kbps (G.711ulaw/G.711alaw)/ 16 Kbps (G.722.1)/16 Kbps (G.726)/32 to 192 Kbps (MP2L2)/8 to 320 Kbps (MP3)/16 to 64 Kbps        |                                       |
|                                 |                                                                                                                                  |                                       |

| Description             | Employer Requirement                                                                                                                             | Manufacturer's guaranteed Particulars |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
|                         | (AAC)                                                                                                                                            |                                       |
| Simultaneous Live View  | Up to 6 channels                                                                                                                                 |                                       |
| API                     | Open Network Video Interface (PROFILE S, PROFILE G, PROFILE T), ISAPI, SDK                                                                       |                                       |
| Security                | Password protection, complicated password, HTTPS encryption, IP address filter,                                                                  |                                       |
|                         | Security Audit Log, basic and digest authentication for HTTP/HTTPS, TLS 1.1/1.2, WSSE and digest authentication for Open Network Video Interface |                                       |
| Network Storage         | MicroSD/SDHC/SDXC card (256 GB) local storage, and NAS (NFS, SMB/CIFS), auto network replenishment (ANR)                                         |                                       |
| Image Enhancement       | BLC, HLC, 3D DNR                                                                                                                                 |                                       |
| Image Parameters Switch | Yes                                                                                                                                              |                                       |
| Built-in Microphone     | Yes                                                                                                                                              |                                       |
| On-board Storage        | Built-in micro SD/SDHC/SDXC slot, up to 256 GB                                                                                                   |                                       |
| Communication Interface | 1 RJ45 10 M/100 M self-adaptive Ethernet port                                                                                                    |                                       |
| Basic Event             | Motion detection (human and vehicle targets classification), video tampering alarm, exception                                                    |                                       |
| Perimeter Protection    | Line crossing detection, intrusion detection, region entrance detection, region exiting detection                                                |                                       |
| Software Reset          | Yes                                                                                                                                              |                                       |
| Startup and operating   | -30 °C to 60 °C (-22 °F to 140 °F). Humidity 95% or less (non-condensing)                                                                        |                                       |
| Power Supply            | 12 VDC ± 25%, reverse polarity protection                                                                                                        |                                       |
|                         | PoE: 802.3af, class 3                                                                                                                            |                                       |
| Power Consumption and   | 12 VDC, 0.55 A, max. 6.6 W                                                                                                                       |                                       |
| Material                | Aluminum alloy body, except for trim ring                                                                                                        |                                       |
| EMC                     | FCC SDoC (47 CFR Part 15, Subpart B);                                                                                                            |                                       |
|                         | CE-EMC (EN 55032: 2015, EN 61000-3-2: 2014, EN 61000-3-3: 2013, EN 50130-4: 2011                                                                 |                                       |
|                         | +A1: 2014);                                                                                                                                      |                                       |
|                         | KC (KN 32: 2015, KN 35: 2015)                                                                                                                    |                                       |
|                         | UL (UL 60950-1);                                                                                                                                 |                                       |



|        |                                                     |  |
|--------|-----------------------------------------------------|--|
| Safety | CE-LVD (EN 60950-1:2005 + Am 1:2009 +<br>Am 2:2013) |  |
|--------|-----------------------------------------------------|--|



| Description                    | Employer Requirement                                                                                                                                                                                                        | Manufacturer's guaranteed Particulars |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Environment                    | CE-RoHS (2011/65/EU); WEEE (2012/19/EU); Reach (Regulation (EC) No 1907/2006)                                                                                                                                               |                                       |
| Protection                     | IP67 (IEC 60529-2013)                                                                                                                                                                                                       |                                       |
| Surge Protection               | 2KV                                                                                                                                                                                                                         |                                       |
| <b>16 Channel NVR</b>          |                                                                                                                                                                                                                             |                                       |
| <b>Descriptions</b>            | <b>Minimum Required Specification</b>                                                                                                                                                                                       |                                       |
| Brand                          | To Be Mentioned By Bidder                                                                                                                                                                                                   |                                       |
| Model                          | To Be Mentioned By Bidder                                                                                                                                                                                                   |                                       |
| Country of Origin              | To Be Mentioned By Bidder                                                                                                                                                                                                   |                                       |
| Country of Manufacturer        | To Be Mentioned By Bidder                                                                                                                                                                                                   |                                       |
| <b>Technical Specification</b> |                                                                                                                                                                                                                             |                                       |
| IP video input (Minimum)       | Minimum 16-channel                                                                                                                                                                                                          |                                       |
|                                | Minimum 12 MP resolution                                                                                                                                                                                                    |                                       |
| Two-way audio                  | 1-ch, RCA (2.0 Vp-p, 1 k $\Omega$ )                                                                                                                                                                                         |                                       |
| Minimum Incoming bandwidth     | Minimum 256 Mbps or 200 Mbps                                                                                                                                                                                                |                                       |
| Minimum Outgoing bandwidth     | Minimum 256 Mbps, or 200 Mbps                                                                                                                                                                                               |                                       |
| Minimum Remote connection      | Minimum 128                                                                                                                                                                                                                 |                                       |
| Recording resolution           | Minimum 12 MP resolution                                                                                                                                                                                                    |                                       |
| VGA1 /HDMI1 output resolution  | HDMI1: 4K (3840 $\times$ 2160)/60Hz, 4K (3840 $\times$ 2160)/30Hz, 2K (2560 $\times$ 1440)/60Hz, 1920 $\times$ 1080p/60Hz, 1600 $\times$ 1200/60Hz, 1280 $\times$ 1024/60Hz, 1280 $\times$ 720/60Hz, 1024 $\times$ 768/60Hz |                                       |
|                                | VGA1: 2K (2560 $\times$ 1440)/60Hz, 1920 $\times$ 1080p/60Hz, 1600 $\times$ 1200/60Hz, 1280 $\times$ 1024/60Hz, 1280 $\times$ 720/60Hz, 1024 $\times$ 768/60Hz                                                              |                                       |
| VGA2 /HDMI2 output resolution  | 1920 $\times$ 1080p/60Hz, 1280 $\times$ 1024/60Hz, 1280 $\times$ 720/60Hz, 1024 $\times$ 768/60Hz                                                                                                                           |                                       |
| Audio output                   | 2-ch, RCA (2.0Vp-p, 1 K $\Omega$ )                                                                                                                                                                                          |                                       |
| Decoding format                | H.265+/H.265/H.264/H.264+/MPEG4                                                                                                                                                                                             |                                       |
| Live view/Playback resolution  | 12 MP/8 MP/6 MP/5 MP/4 MP/3 MP/1080p/UXGA/720p/VGA/4CIF/DCIF/2CIF/CIF/QCIF                                                                                                                                                  |                                       |
| Synchronous playback           | 8-ch                                                                                                                                                                                                                        |                                       |
| Capability                     | 2-ch @ 12 MP (20fps) / 4-ch @ 8 MP (25fps)<br>/ 8-ch @ 4MP (30fps) / 16-ch @ 1080p (30fps)                                                                                                                                  |                                       |
| Network protocols              | TCP/IP, DHCP, DNS, DDNS, NTP, SADP, SMTP, NFS, iSCSI, UPnP™, HTTPS                                                                                                                                                          |                                       |

| Description                              | Employer Requirement                                                                                                                  | Manufacturer's guaranteed Particulars |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| SATA                                     | 2 SATA interfaces                                                                                                                     |                                       |
| Capacity                                 | Up to 6TB capacity for each HDD                                                                                                       |                                       |
| Network interface                        | Minimum 2, RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface                                                                    |                                       |
| Serial interface                         | RS-485; Keyboard                                                                                                                      |                                       |
| USB interface                            | Front panel: 2 × USB 2.0; Rear panel: 1 × USB 3.0                                                                                     |                                       |
| Alarm in/out                             | 8/2.                                                                                                                                  |                                       |
| Power supply                             | 100 to 240 VAC, 50 to 60 Hz                                                                                                           |                                       |
| Max. Power                               | 200 W                                                                                                                                 |                                       |
| Consumption (without HDD)                | ≤ 30 W                                                                                                                                |                                       |
| Working temperature                      | -10 to +55 °C (+14 to +131° F)                                                                                                        |                                       |
| Working humidity                         | 10% to 90%                                                                                                                            |                                       |
| VCA Detection                            | Face detection, Intrusion detection, Cross line detection, Audio detection, Defocus detection, Scene changes detection, Auto tracking |                                       |
| VCA Search                               | Face search, Behavior search                                                                                                          |                                       |
| Statistical Analysis                     | People counting                                                                                                                       |                                       |
| <b>16-Port PoE Network Switch Switch</b> |                                                                                                                                       |                                       |
| <b>Descriptions</b>                      | <b>Minimum Required Specification</b>                                                                                                 |                                       |
| Brand                                    | To Be Mentioned By Bidder                                                                                                             |                                       |
| Model                                    | To Be Mentioned By Bidder                                                                                                             |                                       |
| Country of Origin                        | To Be Mentioned By Bidder                                                                                                             |                                       |
| Country of Manufacturer                  | To Be Mentioned By Bidder                                                                                                             |                                       |
| <b>Technical Specification</b>           |                                                                                                                                       |                                       |
| Port number                              | 16 10/100M PoE+ Ports, 2GE TX/SFP Combo ports                                                                                         |                                       |
| Port type                                | RJ45 port, full duplex, MDI/MDI-X adaptive                                                                                            |                                       |
| Standard                                 | IEEE 802.3, IEEE 802.3u, IEEE 802.3x                                                                                                  |                                       |
| Forwarding mode                          | Store-and-forward switching                                                                                                           |                                       |
| Working mode                             | Standard mode (default); Extend mode                                                                                                  |                                       |
| Ports for long-distance transmission     | Ports 1 to 16                                                                                                                         |                                       |
| MAC address table                        | 4 K                                                                                                                                   |                                       |
| Switching capacity                       | 7.2 Gbps                                                                                                                              |                                       |
| Packet forwarding rate                   | 5.356 Mpps                                                                                                                            |                                       |
| Internal cache                           | 2.75 Mbits                                                                                                                            |                                       |
| PoE standard                             | IEEE 802.3af, IEEE 802.3at                                                                                                            |                                       |
| PoE port                                 | Ports 1 to 16                                                                                                                         |                                       |
| Max. port power                          | 30 W                                                                                                                                  |                                       |
| PoE power budget                         | 130 W                                                                                                                                 |                                       |

| Description            | Employer Requirement                                                                                                                                                                  | Manufacturer's guaranteed Particulars |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Max. power consumption | 150 W                                                                                                                                                                                 |                                       |
| Operating temperature  | -10 °C to 55 °C (14 °F to 131 °F)                                                                                                                                                     |                                       |
| Power supply           | 100 to 240 VAC, 50/60 Hz, Max. 2.5 A                                                                                                                                                  |                                       |
| EMC                    | FCC (47 CFR Part 15, Subpart B); CE-EMC (EN 55032: 2015, EN 61000-3-2: 2014, EN 61000-3-3: 2013, EN 55024: 2010 +A1: 2015); RCM (AS/NZS CISPR 32: 2015); IC (ICES-003: Issue 6, 2016) |                                       |
| Safety                 | CB (IEC 60950-1:2005 + Am 1:2009 + Am 2:2013); CE-LVD (EN 60950-1:2005 + Am 1:2009 + Am 2:2013)                                                                                       |                                       |
| Others                 | CE-RoHS (2011/65/EU); WEEE (2012/19/EU); Reach (Regulation (EC) No 1907/2006)                                                                                                         |                                       |

**21.5 inch Monitor**

| Descriptions                   | Minimum Required Specification                        |  |
|--------------------------------|-------------------------------------------------------|--|
| Brand                          | To Be Mentioned By Bidder                             |  |
| Model                          | To Be Mentioned By Bidder                             |  |
| Country of Origin              | To Be Mentioned By Bidder                             |  |
| Country of Manufacturer        | To Be Mentioned By Bidder                             |  |
| <b>Technical Specification</b> |                                                       |  |
| Display Size                   | 21.5 inches / 54.61 cm                                |  |
| Shape                          | Wide Screen Monitor                                   |  |
| Display Type                   | FULL HD 1080p                                         |  |
| Display Resolution             | Minimum 1920 x 1080 at 60Hz                           |  |
| Brightness                     | 250 cd/m <sup>2</sup>                                 |  |
| Contrast Ratio                 | 1000:1 (Typical)                                      |  |
| Connectivity                   | <b>VGA &amp; HDMI</b>                                 |  |
| Typical viewing angle          | 178° Degree (H) /178° Degree (V)                      |  |
| Backlight Technology           | LED Edgelight System                                  |  |
| Response Time                  | 5 ms typical (black to gray, gray to black)           |  |
| Aspect Ratio                   | >16:9                                                 |  |
| Panel Type                     | In-Plane Switching (IPS); Anti-glare with 3H hardness |  |
| Speaker                        | NO                                                    |  |
| Colour depth                   | 16.7 Million Colours                                  |  |
| I/O Slots                      | NO                                                    |  |
| Warranty                       | 03 Years                                              |  |
| <b>HDMI Cable</b>              |                                                       |  |
| Brand                          | Any International Reputed Brand                       |  |

| Description                                                      | Employer Requirement                                           | Manufacturer's guaranteed Particulars |
|------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------|
| Length                                                           | 5 Meter                                                        |                                       |
| <b>6TB Surveillance HDD</b>                                      |                                                                |                                       |
| <b>Descriptions</b>                                              | <b>Minimum Required Specification</b>                          |                                       |
| Brand                                                            | To Be Mentioned By Bidder                                      |                                       |
| Model                                                            | To Be Mentioned By Bidder                                      |                                       |
| Country of Origin                                                | To Be Mentioned By Bidder                                      |                                       |
| Country of Manufacturer                                          | To Be Mentioned By Bidder                                      |                                       |
| <b>Technical Specification</b>                                   |                                                                |                                       |
| Specifications                                                   | Minimum 6TB                                                    |                                       |
| Product Type                                                     | Surveillance HDD                                               |                                       |
| Interface                                                        | SATA 6Gb/s                                                     |                                       |
| Cache, MB                                                        | 128                                                            |                                       |
| Bytes per Sector                                                 | 4096                                                           |                                       |
| Surveillance Performance                                         |                                                                |                                       |
| Surveillance Performance R/V (Rotational Vibration) Sensor       | Y                                                              |                                       |
| Surveillance Performance Drive Bays Supported                    | 8+                                                             |                                       |
| Surveillance Performance Cameras Supported                       | Up to 64                                                       |                                       |
| Surveillance Performance Max Sustained Data Rate, OD Read (MB/s) | 180                                                            |                                       |
| Warranty                                                         | 1 Year                                                         |                                       |
| <b>128GB Micro SD Card</b>                                       |                                                                |                                       |
| Capacity                                                         | Minimum 128 GB                                                 |                                       |
| Flash Type                                                       | SDXC UHS-I                                                     |                                       |
| Read Speed                                                       | Minimum 170 MB/s                                               |                                       |
| Write Speed                                                      | Minimum 90 MB/s                                                |                                       |
| Operating Temperature                                            | -13 to 185°F/ -25 to 85°C                                      |                                       |
| <b>9U Rack Wall Mount Rack With PDU</b>                          |                                                                |                                       |
| <b>Descriptions</b>                                              | <b>Minimum Required Specification</b>                          |                                       |
| Brand                                                            | To Be Mentioned By Bidder                                      |                                       |
| Model                                                            | To Be Mentioned By Bidder                                      |                                       |
| Country of Origin                                                | To Be Mentioned By Bidder                                      |                                       |
| Country of Manufacturer                                          | To Be Mentioned By Bidder                                      |                                       |
| <b>Technical Specification</b>                                   |                                                                |                                       |
| Dimension                                                        | 9U 500mm(H)x 600mm(W)x 450mm(D)                                |                                       |
| Front Door                                                       | Single glass front door with vented holes & silver handle lock |                                       |
| Rear Panel                                                       | Rear panel with hanging plate                                  |                                       |

| Description                | Employer Requirement                                                                                                                                                                  |                            | Manufacturer's guaranteed Particulars |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------------|
| Side Panels                | Steel Sheet side panels with Round Lock                                                                                                                                               |                            |                                       |
| Mounting profile           | 1.5mm thickness, others are 1.2mm thicknes                                                                                                                                            |                            |                                       |
| Cooling Fans               | Min 2 Pcs with 3pin Power Cord                                                                                                                                                        |                            |                                       |
| Color                      | Black                                                                                                                                                                                 |                            |                                       |
| Cable Entry                | Top & Bottom                                                                                                                                                                          |                            |                                       |
| Philip screws and Nuts     | Min 20 Sets                                                                                                                                                                           |                            |                                       |
| PDU                        | 13AMP Min 6 way PDU with 3 Pin Plug                                                                                                                                                   |                            |                                       |
| 1 KVA Offline UPS          |                                                                                                                                                                                       |                            |                                       |
| Brand                      | Internationally/Nationally Reputed Brand                                                                                                                                              |                            |                                       |
| Model                      | To be Mentioned by bidder                                                                                                                                                             |                            |                                       |
| Country of Origin          | To be Mentioned by bidder                                                                                                                                                             |                            |                                       |
| Capacity                   | Min.1000VA or Higher                                                                                                                                                                  |                            |                                       |
| Backup time                | Minimum 1 Hour For One CPU and Monitor.                                                                                                                                               |                            |                                       |
| Input voltage range        | Minimum 140-300VAC.                                                                                                                                                                   |                            |                                       |
| Frequency                  | 50 Hz + 1%.                                                                                                                                                                           |                            |                                       |
| Protection                 | Fuse. Over load, discharge and overcharge protection.                                                                                                                                 |                            |                                       |
| Output voltage             | 220V/230V + 10%AC                                                                                                                                                                     |                            |                                       |
| Transfer time              | 2-6 ms typically.                                                                                                                                                                     |                            |                                       |
| Battery type               | Lead acid.                                                                                                                                                                            |                            |                                       |
| Recharge time              | Min 8 hrs to 90% after fully discharge.                                                                                                                                               |                            |                                       |
| Exhaust System             | Cooling fan on back                                                                                                                                                                   |                            |                                       |
| DC start up                | Yes.                                                                                                                                                                                  |                            |                                       |
| Protection                 | Built-in Automatic voltage Regulator with lightning surge protection, Spike burnouts, over voltage & under Voltage cut- off, Battery low & over charge protection & Surge protection. |                            |                                       |
| Standard                   | ISO 9001, CE for manufacture.                                                                                                                                                         |                            |                                       |
| Warranty                   | 1 Year.                                                                                                                                                                               |                            |                                       |
| UTP Cat-6 PVC 23 AWG Cable |                                                                                                                                                                                       |                            |                                       |
| Brand                      | To Be Mentioned By Bidder                                                                                                                                                             |                            |                                       |
| Model                      | To Be Mentioned By Bidder                                                                                                                                                             |                            |                                       |
| Country of Origin          | To Be Mentioned By Bidder                                                                                                                                                             |                            |                                       |
| Country of Manufacturer    | To Be Mentioned By Bidder                                                                                                                                                             |                            |                                       |
| Technical Specification    |                                                                                                                                                                                       |                            |                                       |
| Category                   | Cat.6                                                                                                                                                                                 |                            |                                       |
| Reference standard         | ISO/IEC11801, ANSI/TIA-568-C.2, RoHS 2.0                                                                                                                                              |                            |                                       |
| Fire resistance            | No                                                                                                                                                                                    |                            |                                       |
| Conductor                  | Material                                                                                                                                                                              | Solid-Bare Copper (99.95%) |                                       |

|  |          |                         |  |
|--|----------|-------------------------|--|
|  | Diameter | 0.55 ± 0.005 mm, 23 AWG |  |
|--|----------|-------------------------|--|





| Description                    | Employer Requirement                                               |                                                     | Manufacturer's guaranteed Particulars |
|--------------------------------|--------------------------------------------------------------------|-----------------------------------------------------|---------------------------------------|
| Insulation                     | Material                                                           | HDPE                                                |                                       |
|                                | Diameter                                                           | 0.98 ± 0.05 mm                                      |                                       |
| Sheath                         | Thickness                                                          | 0.50 ± 0.10 mm                                      |                                       |
|                                | Diameter                                                           | 6.00 ± 0.30 mm                                      |                                       |
|                                | Material                                                           | PVC                                                 |                                       |
|                                | Color                                                              | Orange                                              |                                       |
| Rip-cord                       | Yes                                                                |                                                     |                                       |
| Separator                      | Yes                                                                |                                                     |                                       |
| Sheath physical properties     | Before aging                                                       | Tensile strength ≥ 13.5 Mpa<br>Elongation ≥ 150%    |                                       |
|                                | Aging period                                                       | 100°C × 24h × 10d                                   |                                       |
|                                | After aging                                                        | Tensile strength ≥ 12.5 Mpa<br>Elongation ≥ 125%    |                                       |
|                                | Cold bend                                                          | -20 ± 2°C × 4h, 8 × cable O.D,<br>no visible cracks |                                       |
|                                | Cable length                                                       | (305 ± 1.5) m                                       |                                       |
| <b>Power cable</b>             |                                                                    |                                                     |                                       |
| Brand                          | To Be Mentioned By Bidder                                          |                                                     |                                       |
| Model                          | To Be Mentioned By Bidder                                          |                                                     |                                       |
| Country of Origin              | To Be Mentioned By Bidder                                          |                                                     |                                       |
| Country of Manufacturer        | To Be Mentioned By Bidder                                          |                                                     |                                       |
| <b>Technical Specification</b> | BYM 1C (2 x 2.5 RM)-BYM PVC Insulated<br>Multi core 300/500V Cable |                                                     |                                       |

|                         |                                                                                                                                                                                                  |  |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| RJ-45 Connector, Cat-6  |                                                                                                                                                                                                  |  |
| Brand                   | To Be Mentioned By Bidder                                                                                                                                                                        |  |
| Model                   | To Be Mentioned By Bidder                                                                                                                                                                        |  |
| Country of Origin       | To Be Mentioned By Bidder                                                                                                                                                                        |  |
| Country of Manufacturer | To Be Mentioned By Bidder                                                                                                                                                                        |  |
| Technical Specification |                                                                                                                                                                                                  |  |
| Product                 | RJ-45 Connector, Cat-6                                                                                                                                                                           |  |
| Brand                   | Mention By the Bidder                                                                                                                                                                            |  |
| Part No                 | Mention By the Bidder                                                                                                                                                                            |  |
| Origin                  | USA/UK/ Taiwan/ Other eligible countries may be accepted where equivalent quality (Please see the instruction,Section-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |  |
| Plug Type               | RJ-45, Cat-6                                                                                                                                                                                     |  |
| Ethernet Speed          | Gigabit                                                                                                                                                                                          |  |
| Molding Type            | snag-less                                                                                                                                                                                        |  |
| Maximum data signal     | Yes                                                                                                                                                                                              |  |
| Housing Unit            |                                                                                                                                                                                                  |  |

| <b>Description</b>                                          | <b>Employer Requirement</b>                                                              | <b>Manufacturer's guaranteed Particulars</b> |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------|
| Brand                                                       | To be Mentioned by bidder                                                                |                                              |
| Model                                                       | To be mentioned                                                                          |                                              |
| Type                                                        | Outdoor                                                                                  |                                              |
| Materials                                                   | Almunium or SS                                                                           |                                              |
| Description                                                 | To be supplied and set as per camera                                                     |                                              |
| Others                                                      | Sample Housing unite to be approved by the authority before installation                 |                                              |
| <b>PVC Pipe/Channel</b>                                     |                                                                                          |                                              |
| Brand                                                       | Mention By the Bidder                                                                    |                                              |
| Model                                                       | To Be Mentioned By Bidder                                                                |                                              |
| Country of Origin                                           | To Be Mentioned By Bidder                                                                |                                              |
| Country of Manufacturer                                     | To Be Mentioned By Bidder                                                                |                                              |
| <b>Technical Specification</b>                              | PVC Pipe/Channel 1/ 1.5 / 2-inch dia minimum wall thickness 1.5 mm.                      |                                              |
| <b>Installation Configuration, Cable Laying and Service</b> |                                                                                          |                                              |
| UTP and Power Cable Laying-Surface                          | UTP Cable and power Laying in building Surface area with Concealed with PVC Pipe/Channel |                                              |
| Installation & Configuration of all CCTV Solution           | VMS Configuration & Camera Installation                                                  |                                              |
| Warranty                                                    | 3 (Three) Years Service warranty                                                         |                                              |

**Seal & Signature of the Bidder**

**Seal & Signature of the manufacturer**

## A. ELECTRICAL

### *3.0 TESTING AND COMMISSIONING*

## **TABLE OF CONTENTS**

| <b>Clause No.</b> | <b>Description</b>                                            | <b>Page</b> |
|-------------------|---------------------------------------------------------------|-------------|
| 3.0               | Testing and Commissioning                                     | 306         |
| 3.1               | Motors                                                        | 306         |
| 3.2               | Relays                                                        | 306         |
| 3.3               | Instrument Transformers                                       | 307         |
| 3.4               | Electrical Instruments and Meters                             | 307         |
| 3.5               | AC Switchboards/ Contacts/L.V Equipment                       | 307         |
| 3.6               | PVC Cable                                                     | 307         |
| 3.7               | Metal Clad Switchgear                                         | 307         |
| 3.8               | Disconnectors and Earth Switches                              | 307         |
| 3.9               | Bushings and Insulators                                       | 308         |
| 3.10              | Current and Voltage Transformers                              | 308         |
| 3.11              | Structures of Electrical Equipment                            | 308         |
| 3.12              | Surge Arresters                                               | 308         |
| 3.13              | Batteries and Battery Chargers                                | 308         |
| 3.14              | Control Panels                                                | 309         |
| 3.15              | Metal Clad Switchgear Busbars                                 | 309         |
| 3.16              | Instruments                                                   | 309         |
| 3.17              | Power Transformers                                            | 309         |
| 3.18              | Station service Transformer                                   | 311         |
| 3.19              | Prior to Shipment                                             | 312         |
| 3.20              | Inspection and Testing During Site Erection and Commissioning | 312         |
| 3.21              | Commissioning Tests                                           | 313         |
| 3.22              | Commissioning of Electrical Equipment                         | 315         |
| 3.23              | Plant Performance                                             | 321         |
| 3.24              | Manufacturer's Standard Tests                                 | 32          |

### **3.0 Testing and Commissioning**

The Contractor shall include comprehensive Inspection and Test Plans in its Quality Plan. Factory testing shall include all type tests and routine tests set out in the relevant IEC standards and in the Particular Technical Requirements.

If satisfactory type tests have been carried out on identical equipment the Contractor shall submit copies of the test certificates to the Employer. The Employer may waive the requirement for any of the type tests if it approves these test certificates.

The Employer will witness all factory inspections and testing. The Contractor shall notify the Employer of its intention to conduct factory inspection and testing for each lot of equipment at least one month in advance, and shall not perform such testing unless the Employer witnesses the test or a waiver has been provided by the Employer.

The notification shall include full details of the equipment, manufacturers and proposed tests, including:

- Contract identification
- Full details of equipment to be tested
- Manufacturer's name, address and contact information Contractor or manufacturer's staff responsible for the testing Location and date of tests
- Schedule of tests to be performed and standard to be applied List of relevant drawings and documents

In the following sections, various relevant standards and tests are listed. These are not intended to be exhaustive. If other standards and/or tests are relevant, they shall also apply.

#### **3.1 Motors**

One motor of each type and rating shall be type tested and all motors shall be routine tested in accordance with the tests specified in IEC 60034, NEMA MG 1, IEEE 112, 114, 115 and 85.

#### **3.2 Relays**

##### **3.2.1 Type Tests**

Type test results shall be submitted for approval for each type and rating of relay.

Type tests may be waived at the Project Manager's discretion if adequate type tests have already been performed and copies of the type test reports are supplied.

##### **3.2.2 Routine Tests**

All relays and associated equipment shall be routine tested as required by the standards to prove the quality and accuracy. Routine tests shall be in accordance with relevant IEC recommendations and BS 142.

All relays shall be subjected to the appropriate routine tests as listed below, the individual tests being as detailed in IEC 60255 or as otherwise agreed with the Project Manager.

- ☐ Accuracy of calibrated pick-up and drop-off levels over the effective range of settings
- ☐ Insulation tests
- ☐ Accuracy of timing elements
- ☐ Correct operation of flag (or other) indicators
- ☐ Mechanical requirements, integrity/safety of draw-out units, check of contact pressure and alignment.

### **3.3 Instrument Transformers**

All required tests shall be carried out as per relevant IEC standards.

### **3.4 Electrical Instruments and Meters**

One instrument and meter of each type and rating shall be subjected to the test as specified in IEC 60051.

### **3.5 AC Switchboards/ Contacts/ L.V Equipment**

Routine tests shall include general inspection and electrical operation tests.

### **3.6 PVC Cable**

Each size and rating of PVC cable shall be subjected to type tests as specified in BS 6346. Routine tests are detailed in this document.

### **3.7 Metal Clad Switchgear**

One circuit breaker, disconnecter, earthing device and other switchgear equipment of each rating and type shall be subjected to the type tests laid down in IEC 60056, ANSI C37, IEC 62271-100 and other relevant IEC standards. In cases where documentary evidence is produced that a circuit breaker of exactly similar design has been type tested by an approved and independent testing station, the type test requirement may be waived.

The circuit breakers of each type shall be either fully assembled at the manufacturer's works and subjected to operation tests and power frequency tests or, where not assembled at works, separate power frequency voltage tests shall be performed on all major insulation components.

Routine tests in accordance with IEC 60056, IEC 62271-100 or ANSI C37 shall be carried out on all circuit breakers. These shall include operation tests; millivolt drop tests and power frequency voltage tests. Routine tests in accordance with the relevant IEC standards, including operation tests and power frequency voltage tests, shall be carried out on all switchgear.

### **3.8 Disconnectors and Earth Switches**

Tests shall be carried out as required according to the following standards:

- ☐ Type and routine tests to IEC 60129 (BS 5253).
- ☐ Type and routine tests to IEC 60265 for switch disconnection.
- ☐ Routine high voltage and mechanical test of insulators.
- ☐ Sample and type tests of insulators

### **3.9 Bushings and Insulators**

Routine, sample and type tests shall be carried out in accordance with the specified standards. Type tests shall also be carried out unless approved type test evidence is submitted. These tests shall include temperature cycle and porosity tests.

The following standards shall apply: -

- ☐ IEC 60233 (BS 4963) for hollow porcelains. IEC
- ☐ 60137 for bushings.
- ☐ IEC 60148 and 60273 (BS 3297) for high voltage post insulators.
- ☐ IEC 60383 and 60305 (BS 137 Part 1 and Part 2) for cap and pin string insulators.

### **3.10 Current and Voltage Transformers**

Type and routine tests shall be carried out according to IEC 60185 (BS 3938), IEC 60186 (BS 3941), IEC 60044-1 and IEC 60044-2.

### **3.11 Structures of Electrical Equipment**

Sample tests on the assembly and galvanizing of the structures shall be carried out. A mechanical type test with the structure loaded with working load multiplied by the appropriate factor of safety shall be carried out.

### **3.12 Surge Arresters**

Routine tests and type tests shall be carried out to the specified standards.

The following routine tests shall be carried out on all arrester units in accordance with clause 8.1 of IEC 60099-4.

- ☐ Measurement of reference voltage Residual
- ☐ voltage test
- ☐ Partial discharge test Housing
- ☐ leakage test
- ☐ Current distribution test for multi-column arrester
- ☐



### **3.13 Batteries and Battery Chargers**

All relevant type and routine tests shall be carried out.

Complete charge and discharge tests on each of the combined batteries and chargers shall be conducted and results recorded so as to permit verification of the ampere-hour capacity of the battery. During these tests the Project Manager shall select at random reference cells and the voltage curves thereof shall be checked when the battery is discharged over three and ten hour periods. The alarm levels and the automatic voltage control feature of the charger shall be demonstrated over the specified load range.

### **3.14 Control Panels**

Routine operation tests and insulation resistance tests shall be carried out.

### **3.15 Metal Clad Switchgear Busbars**

Routine tests including millivolt drop tests shall be carried out in accordance with the specified standard. Type tests shall also be carried out on each busbar design unless approved type test evidence is submitted.

### **3.16 Instruments**

Calibration tests shall be carried out on all important pressure gauges and other instruments as required by the relevant standards. Site tests shall also be carried out to prove compliance.

### **3.17 Power Transformers**

Testing shall include all routine electrical, mechanical and hydraulic tests in accordance with the relevant IEC or British Standard, except where departures there from and modifications thereto are embodied in this specification. For plant not covered by any IEC or British Standard or specifically mentioned in this specification, such tests as are relevant shall be agreed with the Project Manager.

Should the plant, or any portion thereof, fail under test to give the required performance, further tests which are considered necessary by the Project Manager shall be carried out by the Contractor and the whole costs of the repeated tests borne by the Contractor. This also applies to tests carried out at the Sub- contractors' works.

After satisfactory completion of the witnessed tests at the works, the Plant shall be submitted for the Project Manager's approval during dismantling preparatory to shipment. No item of Plant is to be despatched to site until the Project Manager has given his approval in writing.

#### **Routine Tests**

All transformers shall be subject to the routine tests and routine test sequence (mentioned in Section VI Part 2 Electrical Transformer Specification (Clause 5)) in accordance with IEC 60076 and the requirements of this Specification.

The test shall be in accordance with IEC 60076, Part 2, and shall be carried out on one transformer of each size and type. Temperature-rise tests shall be conducted on the tapping corresponding to the maximum losses.

All relevant type tests shall be carried out or documentary evidence of tests on similar designs presented.

### **Temperature Rise Test:**

This shall be carried out in accordance with IEC 60076 Part 2.

### **Noise Level Tests:**

A noise level test according to IEC 60075 shall be carried out on one transformer of each type specified under items 1 and 2 in accordance with IEC 60551.

### **Special Tests**

As mentioned in Section VI Part 2 Electrical Transformer Specification (Clause 5).

#### **3.17.1 Voltage Control Equipment**

The following tests shall be carried out:

##### **Routine Tests**

Each finished tap changer shall be subjected to the routine tests specified in IEC 60214.

##### **Type Tests**

Type tests shall be carried out entirely in accordance with IEC 60214 except that evidence of the service duty type test shall be in excess of 100,000 operations.

#### **3.17.2 Magnetic Circuit**

The following tests shall be carried out:

##### **Routine Tests**

Each core completely assembled shall be tested for one minute at 2,000V AC between core bolts, side plates, structural steelwork and core at the core and coil stage. After the transformer is tanked and completely assembled, a further test shall be applied between the core and the earthed structural steelwork to prove that the core is earthed through the removable link, at one point only.

### 3.17.3 Outdoor Bushing Assemblies with Porcelain Insulators

The following tests shall be carried out:  
Hollow insulators tested in accordance with IEC 60233.

Complete bushings tested in accordance with IEC 60137.

All relevant type and routine tests shall be carried out.

### 3.17.4 Tanks

The following tests shall be carried out:

Routine Tests shall include:

Oil Leakage:

All tanks, conservators and oil filled compartments, which are subjected in service or during maintenance to oil pressure, shall withstand without leakage a hydraulic pressure test equal to  $69 \text{ kN/m}^2$  or the normal pressure plus  $34 \text{ N/m}^2$  whichever is the greater, for 24 hours during which time no leakage or oil ingress into normally oil free spaces shall occur.

Type Tests:

Unless type test certificates can be produced for tests carried out on similar equipment, the following tests shall be included for tanks and conservators.

i) Vacuum Test:

The equipment shall withstand a full vacuum when empty of oil. The permanent deflection of plates or stiffeners on removal of vacuum shall not exceed the following values:

|                      |                                                              |
|----------------------|--------------------------------------------------------------|
| Length of Plate      | Less than 1300 mm<br>1300 to 2500 mm<br>Greater than 2500 mm |
| Permanent deflection | 3.17 mm<br>9.5 mm<br>12.7 mm                                 |

### 3.17.5 Cooling Plant

The following tests shall be carried out:

#### Routine Tests

- ☐ Cooler: Pressure test to be as specified above. Motors
- ☐ and control Gear: as required by the standard

### 3.17.6 Gas and Oil – Actuated

**Relays** The following tests shall be

carried out: Routine Tests:

- ☐ Oil Leakage, when subject to an internal oil pressure of 207kN/m<sup>2</sup> for fifteen minutes. Gas
- ☐ Collection
- ☐ Oil Surge
- ☐ Performance test under service conditions
- ☐ Voltage: 2kV for one minute between electrical circuits and casing.

### 3.17.7 Galvanizing

Routine Tests shall be carried out to the requirements of BS 443 or BS 729 whichever is applicable

## 3.18 Station Service

**Transformer** The following tests

shall be carried out: **Routine Tests**

- ☐ Measurement of Winding Resistance
- ☐ Ratio, polarity and phase relationships
- ☐ Measurement of impedance voltage
- ☐ Measurement of loss
- ☐ Short duration power frequency voltage-withstand test Induced
- ☐ over voltage withstand test
- ☐ Insulation resistance of each winding
- ☐

#### Type Tests

All relevant type tests including a temperature rise test shall be carried out.

Unless acceptable type test certificates can be submitted in respect of a transformer similar in design to that specified, a temperature rise test shall be carried out and the costs shall be included in the contract Price. This test shall take into account temperature rise due to both the specified earth fault current and continuous operation at CMR of the auxiliary winding.

### **3.19 Prior to Shipment**

After the satisfactory completion of all tests at the factory, the plant shall be submitted for the Project Manager's approval during dismantling preparatory to shipping. No item of plant shall be despatched to site until the Project Manager has given approval in writing.

### **3.20 Inspection and Testing During Site Erection and Commissioning**

#### **3.20.1 General**

The Contractor shall be responsible for the inspection and testing during site erection, to ensure correct erection and compliance with the specification. Tests carried out during testing and commissioning shall include those tests listed in this section but shall not be limited to them.

During the course of erection, the Contractor shall provide access as required by the Project Manager for inspecting the progress of the works and checking its accuracy to any extent that may be required.

The Contractor shall provide, at its own cost, all labor, materials, stores, and apparatus as may be required and as may be reasonable demanded to carry out all tests during erection, whether or not the tests are specifically referred to in this specification. All power supplies (including 50Hz AC) shall be provided by the Contractor.

A full site test program shall be submitted for approval. This shall include a brief description of all tests and testing procedures and shall be provided before tests commence and the method of testing, unless otherwise specified, shall be agreed with the Project Manager.

The Contractor shall provide experienced test personnel and testing shall be carried out during normal working hours as far as is practicable. Tests which involve existing apparatus and outages may be carried out outside normal working hours. The Contractor shall give sufficient notice to allow for the necessary outage arrangements to be made in conformity with the testing program.

The Contractor shall record the results of the tests clearly, on an approved form and with clear reference to the equipment and items to which they refer, so that the record can be used as the basis for maintenance test during the working life of the equipment. The required number of site test result records shall be provided by the Contractor to the Project Manager as soon as possible after completion of the tests.

No tests as agreed under the program of tests shall be waived except upon the instruction or agreement of the Project Manager in writing.

The Contractor's test equipment shall be of satisfactory quality and condition and, where necessary, shall be appropriately calibrated by an approved authority at the Contractor's expense. Details of the test equipment and instruments used shall be noted in the test sheets in cases where the instrument or equipment characteristics can have a bearing on the test results.

The testing requirements detailed under this specification may be subject to some variation upon the instruction or agreement of the Project Manager where necessitated by change conditions at site of by differing design, manufacture, or construction techniques.

The Contractor shall be responsible for the safe and efficient setting to work of the whole of the plant and equipment. The methods adopted shall be in accordance with any safety and permit regulations in force by the Employer on the site.

### **3.20.2 Mechanical Equipment**

The extent of testing during erection shall include, but not be limited to, the following.

- ☐ Checking the accuracy and alignment of plant erected. The accuracy shall comply with the relevant standards, the specification or the plant manufacturer's requirements as may be applicable or where no requirements exist, to a standard to be agreed between the Project Manager and the Contractor.
- ☐ Checking the alignment of rotating equipment to the manufacturer's requirements.
- ☐ ☐ Non-destructive testing of site welds as required by the relevant standard and as detailed in this specification.

### **3.21 Commissioning Tests**

At least two months before commencing the commissioning of any plant or equipment, the Contractor shall submit for approval fully comprehensive schedules of pre-commissioning checks as applicable to each item of the plant and equipment provided. These schedules shall then be used during pre-commissioning as a guide to the methods to be followed and to record the actual activities carried out with the appropriate date, together with details of all work yet to be completed, variations and modifications to design conditions.

In addition, the Contractor is to submit with the schedules to the Project Manager proforma test sheets (to be used by the Contractor during testing and commissioning) for all tests he proposes to carry out and those required by the Project Manager.

Each activity on the schedules, when completed to the satisfaction of the Project Manager, shall be signed and dated by the Contractor. The schedules shall be countersigned by the Project Manager as necessary. If during the performance of the pre-commissioning checks the Project Manager considers that additional tests are necessary to prove the system or plant the Contractor shall perform such additional tests to the Project Manager's satisfaction.

Each activity on the commissioning procedure schedules when completed to the satisfaction of the Project Manager, shall be signed and dated by the Contractor and shall be countersigned by the Project Manager as necessary.

The commissioning procedures shall ensure that the commissioning of any section of the Works does not interrupt the normal commercial operation of any previously commissioned section(s).

At least 14 days prior to commencing commissioning checks, the Contractor is to agree with the Project Manager, the method and sequence of performing the commissioning tests. Following agreement, the Contractor shall submit a detailed program indicating the testing sequence to permit advance notice to be given to the Employer in order that the Employer's representatives may also witness testing.

For the purposes of this Contract, the provisions of this section will apply to plant supplied from nominated sub-contractors.

### **3.21.1 Contractor's Site Supervisory Staff**

During the commissioning and subsequent testing of any item of plant the Contractor shall provide the services of any special supervisory staff necessary for the purpose of ensuring proper commissioning and the satisfactory completion of all tests. The cost of any such specialized services is deemed to be part of the bid price for erection of plant.

### **3.21.2 Commissioning of Modified Circuits**

Where the scope of works has included the diversion, relocation or variation of any existing circuit the Contractor is deemed to have included for all pre-commissioning checks on existing equipment. Where this work includes overhead line or cable circuits the Contractor is responsible for carrying out full pre-commissioning and on-load checks at the remote end of the circuit including the injection testing and re-setting of relays if required.

All and any such work associated with the re-commissioning of existing equipment is deemed to be included in the contract price.

### **3.21.3 Test Equipment**

The Contractor is responsible for providing all equipment, power, etc. necessary to carry out all tests on site. Following award of contract, at the appropriate time, the successful Contractor shall submit a detailed schedule of the test equipment etc., he intends to provide for carrying out this portion of the works. Should the Project Manager require additional or alternative test equipment to be provided to enable full site testing to be performed in accordance with the requirements of the specification, the Contractor shall supply such equipment at no extra cost.

### **3.21.4 Owner Participation**

The Contractor shall plan for Employer staff participation either continuously or on a regularly recurring basis in the commissioning work with the primary intent of:

- a) Staff becoming familiar with the operating and maintenance aspects of the new equipment.
- b) Staff maintaining a continuing assessment of the precautions required in, or possible consequences of, initial energization of equipment.

These two objectives must be allowed for in the preparation of schedules.

## 3.22 Commissioning of Electrical Equipment

### 3.22.1 General

A general check of all the main switchgear and ancillary equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, labeling, arcing ring and horn gaps, clearances, painted surfaces, cables, wiring, pipe work, valves, blanking plates and all other auxiliary and ancillary items. Checks shall be made for oil and gas leaks and that the insulators are clean and free from external damage. A check shall be made that loose items which are to be handed over to the employer e.g., blanking plates, tools, spares, are in order and are correctly stored.

The following general tests are to be carried out on electrical equipment after erection at site: -

Routine high voltage tests to the appropriate IEC standard. Where no relevant standard exists, tests shall be agreed with the Project Manager.

- ☐ Insulation resistance tests on all electrical equipment. Continuity
- ☐ and conductivity resistance tests.
- ☐ Test operation of alarm and tripping, devices to local and remote.
- ☐ Rotational tests on all motors.
- ☐ Polarity tests on CTs and VTs. Oil
- ☐ tests.
- ☐ Grounding system and electrode tests.
- ☐ Ratio, vector grouping and magnetizing current tests on each transformer. Calibration
- ☐ of winding and oil temperature devices.
- ☐ Vector group and phasing tests on VT circuits.
- ☐ Magnetization current/voltage tests, knee voltage, accuracy and winding resistance tests on all
- ☐ current transformers.
- ☐ Primary and secondary injection tests on relays, protection devices and equipment.

### 3.22.2 Transformers

The site tests, full details of which are to be submitted by the Contractor after the Contract has been placed, shall include those tests described in outline below.

- (a) Insulation resistance of core and windings.
- (b) Dielectric strength of oil samples.
- (c) Ratio and no-load current at low voltage (e.g. 400 V) on all tapplings.
- (d) Vector notation check.
- (e) Calibration check of temperature instruments, including secondary current injection and proving contact settings.
- (f) Air injection tests of gas/oil-actuated relays.
- (g) Setting check of oil-level and oil-flow devices.
- (h) Complete functional tests of cooling equipment and tap-change equipment, including



manual/automatic sequences, indications, alarms and interlocks, measurement of motor currents, adoption of suitable motor protection settings and proof of protection for stalled or single-phasing conditions.

- (i) Operational tests of breathers.
- (j) Insulation resistance of all secondary circuits.
- (k) Carry out "footprint" tests to confirm that no damage to the windings has taken place during transit and installation.

**(l) Final checks before energizing: -**

Venting, position and locking of valves, earthing of star-point(s) and of tank, state of breathers and of pressure-relief devices, oil levels, absence of oil leakage, operation of kiosk heaters, tap-change counter readings, resetting of maximum temperature indicators, final proving of alarms and trips.

- (m) Dissolved Gas Analysis of transformer oil after final processing

**(n) Tests when energized:**

On-load tap-changer operation throughout range (subject to not exceeding 1.1 pu volts on any windings).

Maintenance of 1.1 pu volts on untapped windings for 15 minutes (but not exceeding this value on tapped winding).

**(o) Tests on load:**

Temperature instrument readings Measurement  
of WTI CT secondary currents

Repeat Dissolved Gas Analysis of transformer oil after energization tests completed

**(p) Oil:**

Samples of oil from each consignment shall be tested in accordance with IEC 60296 before dispatch.

Subject to the agreement of the Project Manager a test certificate, confirming that the oil from which the consignment was drawn has been tested in accordance with IEC 60296, may be accepted. Before commissioning any transformer, the electric strength of its oil shall be check-tested and results approved by the Project Manager.

### 3.22.3 Circuit-Breakers

Circuit-breakers shall be given a visual inspection.

In the case of gas type circuit-breakers testing will be required on the gas system to prove the gas pressure, quantity, dryness and dielectric strength.

Contact resistance tests shall be carried out. In the case of multi-interrupter circuit-breakers resistance tests will be required at each interrupter or pair of interrupters as well as through the series of interrupters on each pole.

Local air components associated with pneumatic operation, including air compressors, shall be tested and air loss measurements and pressure and alarm settings checked. Tests shall be made also on mechanical and hydraulic operation systems.

### 3.22.4 Disconnectors and Earth Switches

Manual operation of disconnectors and earth switches shall be subject to operational tests to confirm contact pressures, contact resistances, simultaneous operation of all phases and the ease of operation.

Motorised operation of disconnectors and earth switches shall be tested to prove the motor operation, including local and remote operation, and timing tests shall also be carried out. Motor protection shall be tested.

Checks shall be made on interlocks, local and remote indications and operation of auxiliary contacts.

Earth switches shall be tested to confirm the opening and closing sequences and checks shall be made on interlocks, indications and manual locking devices.

### 3.22.5 Busbars and Connections

Flexible busbars and connections shall be tested to ensure that the correct tensions, sags and clearances will be maintained over the range of environmental conditions and loads without stress to other equipment. If dynamometers are used to check the sags and tensions, they shall be checked both before and after use.

Rigid busbars and connections shall be tested to ensure that the busbars will not cause overloading of the supporting insulators under load conditions and under the range of climatic variations applicable to the site and that expansion and contraction of the equipment is fully accommodated by flexible connections.

Conductivity tests shall be carried out on all connections and joints which are made on site, without exception.

### 3.22.6 Earthing System

Tests shall be made on the effectiveness of the bonding and earthing which will include conductivity tests on selected joints, on the main earthing system, and at the connections to equipment and structures. Checks shall also be made on precautions taken to avoid corrosion attack on the earthing system.

Test probes at approximately 300 and 600 meters separation will normally be required to effectively test the earthing system. The use of transmission line conductors may be arranged to simplify test testing procedures.

The earth resistance shall be measured during the installation and on completion as follows: - of

- ☐ each earth rod after driving

- ☐ of the earth grid after completion and back-filling of the trenches
- ☐ of each group of earth rods or earth point after completion of the connection from the test link terminal.
- ☐ Of the completed installation without any connections outside the substation

The tests shall be carried out by a method and with equipment approved by the Project Manager. All tests are to be witnessed and the equipment and method used recorded with the test results.

The Contractor may also be called upon to provide assistance in the measurement of earth resistance after earth connections to the system have been completed.

### **3.22.7 Control Relays and metering Panels, Instruments and Protective Devices**

#### **(a) Wiring**

After complete erection and cabling, all circuits shall be subjected to the high voltage test specified in the relevant IEC or approved standard.

The insulation resistance of all circuits shall be measured before and after any high voltage tests. For

AC secondary injection tests, a substantially sinusoidal test supply shall be used.

The operation and resetting level (current and/or voltage) and timing of all relays shall be measured over an agreed range of settings for all relays.

Other relays shall be fully tested in accordance with the manufacturer's recommendations. All

DC elements of protection relays shall be tested for operation at 70% rated voltage.

All d/c supplies shall be checked for severity of current inrush when energized by switching on or inserting fuses or links.

#### **(b) Mechanical Inspection**

All panel equipment is to be examined to ensure that it is in proper working condition and correctly adjusted, correctly labeled and that cases, covers, glass and gaskets are in good order and properly fitting.

#### **(c) General**

Sufficient tests shall be performed on the relays and protection schemes to:

- ☐ Establish that the equipment has not suffered damage during transit. Establish that the correct equipment has been supplied and installed.
- ☐ Confirm that the various items of equipment have been correctly interconnected.
- ☐ Confirm performance of schemes designed on the bases of calculation e.g., differential protection.
- ☐ To provide a set of figures for comparison with future maintenance values allowing the condition of the equipment to be determined.

#### (d) Secondary Injection

Secondary injection shall be carried out on all AC relays, using voltage and current of sinusoidal wave form and rated power frequency to confirm satisfactory operation and range adjustment.

The polar characteristic of all distance protections shall be recorded at a minimum of 30 degree intervals.

For circulating current protection employing high impedance voltage operated relays, the points of injection for relay voltage setting tests shall be across the relay and stabilizing resistance.

The fault setting for the type of protection is to be established by secondary injection, where it is impracticable to ascertain this value by primary injection. Injection is to be made across the appropriate relay bus wires with all associated relays, setting resistors, and CT's connected.

#### (e) Primary Injection

All current operated relays shall be tested by injection of primary current to record the actual relay setting and as a final proof of the integrity of all secondary connections.

The stability of all differential schemes shall be checked by injection of primary current.

Primary current injection tests are to be carried out by the Contractor and the methods employed for a particular installation are to be agreed with the Project Manager.

Tests are to be carried out as follows:

- ☐ Local primary injection to establish the ratio and polarity of current transformers as a group, care being taken to prove the identity of current transformers of similar ratio.
- ☐ Overall primary injection to prove correct interconnection between current transformer groups and associated relays.
- ☐ Fault setting tests, where possible, to establish the value of current necessary to produce operation of the relays.

#### (f) DC Operations

Tests are to be carried out to prove the correctness of all DC polarities, the operating levels of DC relays and the correct functioning of DC relay schemes, selection and control switching, indications and alarms. The correct functioning of all isolation links and fuses shall also be checked.

#### (g) Tests on Load

Tests on load shall also be done to demonstrate stability and operation of protection relays as required by the Project Manager.

All tripping, control, alarm and interlocking circuits shall be functionally tested to prove satisfactory and full proof operation and/or resetting. The functional and safety aspects of all shorting and/ or isolation links, fuses and switches devices shall be proved.

The total burdens connected to all voltage transformer circuits shall be measured and recorded.

The total capacitance of all wiring and apparatus connected to the negative pole of each main tripping battery shall be measured and recorded; the value shall not exceed 10 microfarad.

The continuous current drain of all trip circuit supervision relays shall be measured and shall not be greater than half the minimum current required for tripping. The supervision current shall be measured with the circuit-breaker (or other device) both open and closed.

## **Batteries and Chargers**

Tests shall be carried out on the batteries and chargers to confirm the charger ratings and adjustment, the battery and charger alarm systems and battery capacity.

The open-circuit cell voltages of the batteries when fully charged shall be recorded. The

insulation to earth of the complete DC installation shall be tested.

## **Power Cables**

Each completed circuit shall be tested for continuity and insulation resistance.

## **Current Transformers**

A magnetization curve shall be obtained for each current transformer in order to: -

- ☐ Detect damage in transit or installation
- ☐ Prove that the correct cores have been wired out to the relevant terminals
- ☐ For high impedance relay schemes, to confirm that correct relay settings have been calculated.
- ☐ The DC resistance of each current transformer secondary winding shall be measured and also the transformers and connection leads, each item being recorded separately.
- ☐ The insulation resistance of all secondary circuits shall be measured at 1000 volt and recorded.

Primary current injection tests shall be conducted on all current transformers using adequate primary current to prove correct ratio, polarity and, for differential protection schemes, to prove the correct relative polarities of all current transformers of each scheme.

## Voltage Transformers

The transformer ratio and polarity shall be checked using a primary voltage high enough to give a clearly measurable secondary voltage or by using rated primary voltage and comparison with an already proven voltage transformer. The phasing and phase rotation shall be checked. For three phase voltage transformers a test shall be conducted to show that energizing each primary winding produces an output from only the correct phase secondary winding. The residual voltage of any open delta or broken delta winding shall be measured with rated primary voltage applied.

## Control and Instrumentation Equipment

The following general tests shall be performed on control and instrumentation equipment at site:

- ☐ Insulation resistance testing of all circuits.
- ☐ Functional tests for all tripping, control, alarm and interlocking circuits.

The testing of all equipment in accordance with the manufacturer's instructions or as advised by the Project Manager.

## Transformers and Ancillary Equipment

The following tests shall be performed.

- ☐ Insulation resistance tests on bushings.
- ☐ Insulation resistance test at 500V between core and core clamping structure. Voltage withstands tests on insulation oil to BS 148.
- ☐ Ratio test.
- ☐ Phase relationship
- ☐ Magnetization characteristics of current transformers of winding temperature devices. Calibration of winding temperature devices.
- ☐ Tap Selector and Diverter Switch alignment.
- ☐ Calibration of automatic voltage control equipment.
- ☐ Proving tests as necessary on control schemes.
- ☐ Measurement of winding resistance on all taps and phases.
- ☐

### 3.22.8 Inspection Plan and Procedures

### 3.22.9 Measuring and Testing Equipment's

At prescribed intervals, or prior to each use, all measuring and testing equipment used in inspection shall be calibrated and adjusted against certified equipment having a known valid relationship to nationally recognized standards. Where no national standards exist, the basis employed for calibration shall be approved by the Project Manager.

The manufacturer shall prepare a calibration schedule showing equipment type, identification number, location, frequency of checks, method of checking and action to take when results are unsatisfactory.

Each piece of equipment shall be labeled with its identification and current calibration status.

Calibration records for each piece of equipment shall be maintained at least for life of that piece of equipment and shall be available for examination by the Project Manager.

### **3.22.10 Re-inspection Following Non-Conformance**

If a non-conformance report is issued as specified in this clause and the clause below, the Contractor shall reimburse the Project Manager for all costs incurred by its staff (including time costs, travel, accommodation etc.) for both attending discussions on remedial matters and any re-inspection that the incurred by its staff may deem to be necessary.

## **3.23 Plant Performance**

### **3.23.1 Guarantees**

Bidders shall state and guarantee the technical particulars listed in the Schedules of Technical Particulars and Guarantees. These guarantees and particulars shall be binding and shall not be deviated from without the written permission of the Project Manager.

The tolerances permitted in the IEC or other standard shall apply unless otherwise stated.

### **3.23.2 Rejection**

If the guarantees are not met and/or if any items fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or during the maintenance period, the Project Manager may reject the item, or defective component thereof, whichever he considers necessary, and after adjustment or modification as directed by the Project Manager, the Contractor shall submit the item for further inspection and/or test. The repair procedure shall be to the Project Manager's approval. In the event of a defect on any item being of such a nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item shall be replaced by the Contractor, at his own expense to the entire satisfaction of the Project Manager. Any item of plant repaired to an approved procedure shall not be accepted as a part of the Works as a permanent solution or replacement unless the Contractor guarantees in writing that the repaired plant or component shall have the same service life and efficiency as the component originally manufactured.

## **3.24 Manufacturer's Standard Tests**

### **3.24.1 General**

Where no specific test is specified then the various items of plant, materials and equipment shall be tested in accordance with the appropriate IEC standard. Where no appropriate standard is available, tests shall be carried out in accordance with the maker's standard practice, subject to the prior approval of the Project Manager. In all cases, works tests shall include electrical mechanical and hydraulic tests in addition to any tests called for by the Project Manager to ensure that the plant being supplied fulfills the requirements of the Specification.

If considered necessary by the Project Manager any multi-part assemblies shall be fully erected in the Works prior to packing and dispatch to Site.

All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Project Manager prior to commencement of the work. The inspection schedule included in the Schedules of Miscellany shall be used for this purpose. The Contractor shall prepare the details of the schedule and submit these to the Project Manager for approval.

It must be ensured that adequate relevant information on the design, code/standard employed, the manufacture/fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Project Manager. The Project Manager will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections.

A minimum of 14 days notice in writing, of the readiness of plant for test or inspection shall be provided to the Project Manager by the Contractor in accordance with the following:

The Contractor shall submit to the Project Manager sequentially numbered applications for inspection which shall contain the following information.

- ☐ Contract number
- ☐ Contract title
- ☐ Contractors Name
- ☐ Inspection application number
- ☐ Manufacturers name, address, telephone and telex numbers, plus name of manufacturers staff responsible for the testing and manufacturer's works order number.
- ☐ Location of tests
- ☐ Date of tests
- ☐ Description in full of Plant offered for inspection (Contractors order references alone are insufficient and unacceptable)
- ☐ Section of the Works for which Plant is allocated.
- ☐ Schedule of tests to be performed and standard to be applied.
- ☐ List of the Employer's approved drawing numbers appropriate to the Plant offered
- ☐ Sub-order number

The subject items should remain available for the Project Manager inspection and test up to a minimum of 10 days beyond the agreed date of witnessing the test.

Every facility in respect of access, drawings, instruments, and manpower shall be provided by the Contractor and his Sub-contractor to enable the Project Manager or his designated representative to carry out the necessary inspection and testing of the plant.

No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, and approved for shipment, or alternatively inspection has been waived. The Contractor shall request permission to dispatch in writing.



Functional electrical, mechanical and hydraulic tests shall be carried out on the completed plant after assembly in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Project Manager in sufficient time to enable the tests to be satisfactorily witnessed, or if necessary for any changes required to the proposed programme of tests to be agreed.

All instruments and apparatus used in the performance of the tests shall be to the approval of the Project Manager, and, if required by the Project Manager, shall be calibrated to an agreed standard at the National Physical Laboratories or equivalent centre and approved by the Project Manager.

The cost of carrying out such calibrations shall be borne by the Contractor in all cases.

The Project Manager reserves the right to visit the Contractor's works at any reasonable time during manufacture of the items of plant and to familiarize him with the progress made and the quality of the work to date.

### **3.24.2 Test Certificates**

Within 30 days of the completion of any test, four sets of all principal test records, test certificates and correction and performance curves for the plant and its component parts shall be supplied to the Project Manager.

These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Project Manager or his Representative. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the contract reference title. It shall be possible to identify the item of plant to which a specific test certificate refers, including those of sub-components and the specific site for which the item is allocated.

Contractors order numbers or drawing reference numbers are not sufficient for this purpose without a description of the plant involved.

Test certificate shall provide full details of the measurements of their tolerances, and actual test values obtained. Certificates simply stating phrases such as 'Passed' or 'Tested in accordance with' are not acceptable.

When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the Contractor into volumes and bound in an approved form, complete with index and included in the appropriate operation and maintenance manuals.

## **B. CIVIL**

### **4.0 TECHNICAL REQUIREMENTS**

## **FOR SUBSTATION CIVIL AND BUILDING WORKS**

## **TABLE OF CONTENTS**

| Clause No. | Description                                                 |
|------------|-------------------------------------------------------------|
| 4.1        | Introduction                                                |
| 4.2        | Design and Construction Standards                           |
| 4.3        | Units of Measurement                                        |
| 4.4        | New 33/11 kV 10MVA or 20MVA Sub Stations                    |
| 4.5        | Site Analysis and Topographical Survey                      |
| 4.6        | Subsoil Investigations                                      |
| 4.7        | Laboratory Testing                                          |
| 4.8        | Bulk Earthworks                                             |
| 4.9        | Building Foundations                                        |
| 4.10       | Civil Work                                                  |
| 4.11       | Design and Construction Requirements and Interchangeability |
| 4.11.1     | General Requirements                                        |
| 4.11.2     | Specific Requirements                                       |
| 4.12       | Plant and Equipment Identification                          |
| 4.12.1     | Identification on Drawings                                  |
| 4.12.2     | Labels and Nameplates                                       |
| 4.13       | Safety and Security                                         |
| 4.13.1     | Interlocks                                                  |
| 4.13.2     | Locks, Padlocks, and Key Cabinets                           |
| 4.14       | Commissioning Spares                                        |
| 4.15       | Consumable Items                                            |
| 4.15.1     | Chemicals and other Consumable                              |
| 4.16       | Painting and Cleaning                                       |
| 4.17       | Galvanized Work                                             |
| 4.18       | Steel Pipe Work                                             |
| 4.19       | Bolts, Studs, Nuts and Washers                              |
| 4.20       | Architectural and Structural Requirements of Buildings      |
| 4.20.1     | Architectural Planning and Design                           |
| 4.20.2     | Structural Design                                           |
| 4.21       | Utility Services                                            |
| 4.22       | Fire Detection and Protection Facilities                    |
| 4.23       | Grid Substation Sending End Bays for New Substations        |
| 4.24       | Preparation of the Site                                     |
| 4.25       | Temporary Buildings on Site                                 |
| 4.26       | Access to the Site                                          |
| 4.27       | Site Drainage                                               |
| 4.28       | Site Maintenance during Construction                        |

## 4.1 Introduction

This contract is being Bided as a turnkey contract, in which the selected contractor will be responsible for carrying out all civil works designs, including preparing working drawings and specifying materials to be used in all temporary and permanent works. This section describes the General Technical Requirements for all civil works, which include earthworks, the construction of foundations, structures, architectural features and all associated works required for REB 33/11 KV Indoor Rural Type Substations, fitting out structures, buildings and associated works, and erecting, installing and commissioning of all Substation plant. This section shall be read in conjunction with the Project Requirements, Schedules and Drawings.

The Contractor shall appoint a team of qualified and experienced engineers and other specialists to undertake the detailed design of all civil and associated works, and shall submit all completed designs, drawings and supporting calculations to the Project Manager for approval before site work commences.

## 4.2 Design and Construction Standards

The design and construction shall conform to the latest edition of the relevant codes of practice and standards listed below and in individual clauses in this document relating to specific materials or practice. Any proposed substitution for the listed standards by an equivalent standard shall be subject to approval by the Employer.

|                           |                                                                                            |
|---------------------------|--------------------------------------------------------------------------------------------|
| AASHTO                    | American Association of State Highway and Transportation codes for site access road design |
| ACI 318-89                | Building Code Requirements for Reinforced                                                  |
| Concrete ASTM             | American Society for Testing and Materials                                                 |
| BNBC                      | (Bangladesh National Building Code) with requirements for building works                   |
| BS 12                     | Portland Cement                                                                            |
| BS EN 124                 | Gully and Manhole Tops for Vehicular and Pedestrian Areas                                  |
| BS 812                    | Testing Aggregates                                                                         |
| BS 882                    | Aggregates from Natural Sources for Concrete                                               |
| BS 1387                   | Specification for Screwed and Socketed Steel Tubes                                         |
| BS EN ISO 1461            | Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles                          |
| BS 1881                   | Testing Concrete                                                                           |
| BS EN 1992-1-1            | Design of Concrete Structures (includes                                                    |
| foundations) BS EN 1997-1 | Geotechnical Design                                                                        |
| BS 2853                   | Design and Testing of Overhead Runway Beams                                                |
| BS 3148                   | Methods of Testing for Water for Making Concrete                                           |
| BS 3921                   | Clay bricks                                                                                |
| BS 4449                   | Steel Bars for the Reinforcement of                                                        |
| Concrete BS 5262          | External Renderings                                                                        |
| BS 5395                   | Stairs, Ladders and Walkways                                                               |
| BS 5572                   | Sanitary Pipe Works                                                                        |
| BS 5628                   | Code of Practice for use of Masonry                                                        |

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|                 |                                                                                            |
|-----------------|--------------------------------------------------------------------------------------------|
| BS 5930         | Code of Practice for Site Investigations                                                   |
| BS 6031         | Code of Practice for Earthworks                                                            |
| BS 6367         | Code of Practice for Drainage of Roofs and Paved Areas                                     |
| BS 6399: Part1  | Code of Practice for Dead and Imposed Loads                                                |
| BS 6399: Part 2 | Code of Practice for Wind Loads                                                            |
| BS 6465         | Sanitary Installations                                                                     |
| BS 6651         | Code of Practice for Protection of Structures against Lightning                            |
| BS 6700         | Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use |
| BS 8004         | Code of Practice for Foundations                                                           |
| BS 8005         | Sewerage                                                                                   |
| BS 8100         | Lattice Towers and Masts                                                                   |
| BS 8102         | Code of Practice for Protection of Structures Against Water                                |
| BS 8110         | Structural Use of Concrete                                                                 |
| BS 8206-2       | Lighting for Buildings                                                                     |
| BS 8215         | Code of Practice for Design and Installation of Damp-proof Courses in Masonry              |
| BS 8290         | Suspended Ceilings                                                                         |
| BS 8301         | Code of Practice for Building Drainage                                                     |

### 4.3 Units of Measurement

All designs and measurements in this Contract shall be provided in the International System of Units (SI) in accordance with the provisions of ISO 31 and ISO 1000.

### 4.4 New 33/11 kV 10 MVA or 20 MVA Sub Stations

Two storied buildings with three storied foundations will be designed and constructed to establish a 33/11.55 kV, 10/14 MVA (1x10/14 MVA) or 20/28 MVA (2x10/14 MVA) Substations, with associated work including control room, complaint room, guard room, service road, RCC & boundary wall, drainage system, fencing with around power transformer work, landscaping and beautification work and other related works.

The Contactor shall be responsible for the design and construction of the Substation and associated work, which will include the following:

- ☐ Topographical survey as part of site analysis
- ☐ Subsoil investigation, sampling and laboratory testing
- ☐ Master plan including services road, landscaping (beautification work) as per respective site condition
- ☐ Conceptual alternative studies of site plans shall be undertaken for individual sites, study and architectural planning of individual units. The site plan shall consider the building and other facilities/utilities like circulation roads, parking, utility networks, landscaping and boundaries.
- ☐ Foundation works
- ☐ Architectural plan, section, all side elevation including 3-D perspective of the building.
- ☐ Structural design as per present code of practices in Bangladesh (BNBC), detail drawings for construction works.
- ☐ All required temporary works.
- ☐ Earth works requirements as per site condition.
- ☐ Time schedule/work programme, BOQ including rates and all other document, Maintenance and Operation Manual as required for the process.

**The sites of sub-station like DACOP-3 (SRINAGAR), KOYRA-2 (2 No. KOYRA) and DUMURIA-5 (MADARTOLA) of Khulna PBS are situated in the coastal area. These areas experience a number of disastrous Cyclone and Water-Surge in every year. Due to the climate change, it can be assumed that, more severe natural calamities will occur in these areas in the coming years. The proposed Sub-stations are the key installation of the power network under Khulna PBS. Considering the present and future climatic condition the 'Earth Filling Height', 'Control Room and Transformer Pad' should be designed in accordance with the water surge and Cyclone intensity. So that, The Sub-Stations would be able to sustained with the extreme weather conditions.**

**The above additional requirement shall be considered by the bidder while preparing their bid proposal. The said requirement will be reflected in the drawing and also drawing approval from BREB must be required before the construction work.**

## 4.5 Site Analysis and Topographical Survey

The proposed substation sites are located as per drawing locations of Bangladesh. They are mainly in low lying areas and predominantly paddy land. The Contractor shall carry out a topographical survey of all substation sites prior to design work commencing, using the most modern survey equipment available in the country. The Contractor shall first establish a benchmark on or immediately adjacent to each site on a permanent structure, and establish its level relative to the nearest PWD benchmark. Detailed digital plans of each site shall be prepared using AutoCAD at a scale agreed by the Project Manager showing all existing physical features and other information as listed below and, to the extent necessary, the survey shall extend beyond the site boundaries to capture adjacent information:

- (a) contours at intervals agreed by the Project Manager, extending into the immediate surroundings of the site;
- (b) boundary line of the site;
- (c) above ground physical features such as roads, including the nearest National or other main road, tracks, structures, utilities and plantations;
- (d) the location of below ground utilities including piped water supply, gas, drainage, sewerage and tube wells;
- (e) the highest flood level (HFL) at the site and its surrounding areas, related to the benchmark;
- (f) the nearest points at which connections could be made to existing water, electricity and gas supplies, if available

## 4.6 Subsoil Investigations

The Employer has no any previous soil test reports for each sub-station site to provide to the bidder. However, the Contractor shall be fully responsible for all foundation design and must conduct his own subsoil investigations at every site, the main purpose of which is to determine, within practical limits, the stratification, ground water table and engineering properties of the soils underlying the sites of the proposed buildings. The principal properties of interest shall be the strength, bearing capacity and settlement characteristics of the underlying soils. Efficient, safe, economical design and construction can be achieved only through adequate evaluation of soil conditions of the proposed construction.

The Contractor may appoint a sub-contractor (if required) to carry out the site investigations but all work and all lab work shall be witnessed by one of his own staff who shall countersign all recorded data.

The record of all boring shall include but not limited to the following information:

- (a) Size of the casing (if used)
- (b) Number of blows per 300mm required to drive the sampling spoon and data should be recorded every 1.5 m intervals.
- (c) The elevation of the ground surface referred to an established datum
- (d) Location and depth of boring and its relation to the proposed construction

- (e) Elevation at which samples are taken
- (f) Elevation of the boundaries of soil strata
- (g) Description of soil strata encountered and any particular unusual or special condition such as loss of water in the earth and rock strata, boulders, cavities and obstructions, use of special type of samplers, traps etc.
- (h) The level of ground water together with a description of how and when ground water level was observed

A minimum of five boreholes or augurs shall be drilled at each Substation site and if the results vary across the site, the Project Manager shall determine whether and how many additional boreholes shall be drilled.

#### **4.7 Laboratory Testing**

The following soil tests shall be performed in a laboratory approved by the Project Manager for evaluation of soil parameters:

- (a) Grain size analysis
- (b) Specific gravity
- (c) Unit weight (wet & dry)
- (d) Natural moisture content
- (e) Unconfined compression strength
- (f) Direct shear
- (g) Consolidation test

The Contractor's Soil Investigation Reports for each site shall propose full details of foundations and loading thereon and shall provide estimates of total settlements and differential settlements of the underlying soil deposits and substantiate the recommendations regarding type of foundation. The site investigations and analysis of the data in the Reports shall contain but not be limited to the following:

- (a) Location of ground water level
- (b) Bearing capacity of the soil
- (c) Comparison of alternative types and/or depths of foundation
- (d) Data on soil parameters and properties
- (e) Settlement predictions
- (f) Risks if any to property adjacent to the site.
- (g) End bearing value and skin friction for pile design

#### **4.8 Bulk Earthworks**

The existing level of all sites are below the HFL, in some cases by up to 5 m, and filling is required to raise the site level above HFL. The raised ground level of all sites shall be either 600 mm above the HFL or equal to the level of the nearest main road to the site, whichever is the higher, and also determined such that water shall not drain from the approach road or main road to the site. It is the



Contractor's responsibility to determine the fill height required from the topographical survey data in accordance with the above criteria.

Slope protection works shall also be designed and carried out. This protection should be mainly by the construction of reinforced concrete retaining walls, Cast in situ concrete piles or seasoned wooden piles, which shall be dependent on the height of filling required as well as existing sub-soil. The

Contractor may select and design the type of retaining wall considering the Soil Investigation Reports and the following:

- (a) RCC retaining wall with deep foundation shall be selected where the filling height is above 3.0 m. The foundation (Consider Cast in situ concrete Pile where Piling required) of the wall shall be dependent on the sub soil report.
- (b) Cast in situ pile shall be considered where the filling height between 2.0 m to 3.0 m. The spacing of the pile shall depend on the filling height and size of pile. RCC retaining wall will be constructed of 100% of Retained height of wall.

The fill materials shall be deposited and spread in successive uniform horizontal layers of about 150mm thick and compacted by use of mechanical 1.5 ton "Vibro" compactor or other approved devices to a 98% standard dry density in road and pavement sub-base and 95% standard dry density for other areas. In filling /back filling against a newly constructed structure precaution must be taken so that the structure is well matured to take the thrust of filling and when filling against a wall, the filling shall be carried out from both sides simultaneously.

Tests shall be carried out at a recognized laboratory to ascertain the nature of the fill material and the degree of compaction obtained for the filled material for which samples shall be taken and transported to the recognized laboratory by the Contractor at his cost and as directed by the Project Manager.

#### **4.9 Building Foundations**

The type of foundations required will be selected and designed by the Contractor based on the results of the subsoil investigation and testing program at each new Substation site. The foundations may be either shallow (spread footings or mat) foundations or deep (pile) foundations according to subsoil conditions. The Contractor shall submit his foundation design with full supporting calculation for the approval of the Project Manager. Design shall be according to BS EN 1992-1-1 and BS EN 1997-1. If deep piles are required, the submission shall include full details of the type of pile (bored or driven) and the proposed construction sequence.

#### **4.10 Civil Work**

Each Substation shall be designed with a two storied control room building (with a foundation suitable for three stories) with an approximate floor area of (12x20) 240 sq. m. per story.

- Ground Floor (Ceiling Height 3 m): Cable lay & Security room, Complaint Centre, Rest Room and Toilet.

- ☐ ☐ First Floor (Ceiling Height 3.8 m): 33 kV & 11 kV Switchgear, Control Room, Battery Room, Toilet (01 No.).
- ☐ ☐ Stair with four flights (run width = 25 cm, riser height = 15 cm and railing with SS Pipe. Stair shall be up to 2<sup>nd</sup> floor.
- ☐ ☐ Great beam height of control room building to be 60 cm above finished ground level.
- ☐ ☐ The outside wall of the control room building shall be covered with Ceramic Bricks and the floor of the control room shall be tiles finishing. Tiles shall be from any reputed foreign brand.
- ☐ One no. opening with shutter (2.0 m wide and full first floor height) at the outer wall of the first floor of the control room building at a suitable position as per instruction of the Project Manager (for materials to be carried on the first floor or carried out from the first floor).
- ☐ Oil Containment bund walls – for oil drain out one tank to be provided along/beside the transformer pad.
- ☐ Cable Trench, Duct and Sump Pits: Cable Trench depth should be provided above flood level of that area i.e. we should be able to avoid water logging in the cable trench.
- ☐ RCC Retaining wall along the property line and matching main and personnel gates: RCC Retaining wall to be constructed along the property line of Substation area including matching main and personal gates. Structure and foundations for line landing gantries, plant and equipment. All foundations (Consider Cast In Situ Concrete Piling where Piling is required) (including future provisional equipment foundations if required), ducts/ drainage, Power & Control Cable, fencing with around power transformer, Fire wall, RCC & boundary wall and Trench heavy quality stainless steel gates. Name plate of substation as approved by project office shall be included.
- ☐ 33/11 kV Transformer Foundation: Solid power transformer foundation (including future provision) may be considered in that case rail provision to be provided above x-former pad.
- ☐ FGL of substation yard should be 60 cm above the highest flood level.  
. Please collect the flood level data from the concerned authority of Government of Bangladesh.
- ☐ Substation yard surface finishing should be with 25 – 30 mm washed stone gravelling of 7-10 cm depth.
- ☐ Construction of RCC internal roads (as required).
- ☐ Substation yard surface finishing should be with 2" – 3" washed stone gravelling of 4" depth.

- ☐ Supply and installation of Air Conditioning System for Control Room including all other accessories/ components required for fitting & fixing up to commissioning.
- ☐ Installation of CCTV System in suitable for place including all other accessories/ components required for fitting & fixing up to commissioning
- ☐ Supply and installation of submersible water pump motor set for safe drinking water including borehole drilling, pipes and all other accessories/ components required for fitting & fixing up to commissioning.
- ☐ All necessary furniture for the Control Room.
- ☐ Supply and installation of whole substation security lights.
- ☐ Material test results used in construction works.

## **4.11 Design and Construction Requirements and Interchangeability**

### **4.11.1 General Requirements**

The Works shall be designed to operate safely, reliably and efficiently in accordance with the design and operating requirements stated in this Specification. No violation from the Specification shall be made subsequent to the Contract without the written approval of the Project Manager.

Each of the several parts of the Plant to be provided shall be of the manufacturer's standard design, provided that this design shall be in accordance with an international code of practice and generally in accordance with this Specification.

The design, dimensions and materials of all parts shall be such that they shall not suffer damage as a result of stresses under the most severe service conditions. The materials used in the construction of the Plant shall be of the highest quality and selected particularly to meet the duties required of them. The plant shall be designed and constructed to minimize correction. Workmanship and general finish shall be of the highest class throughout.

All plant items and corresponding parts performing similar duties shall be interchangeable in order to minimize the stock of spare parts.

All equipment shall be designed to minimize the risk of fire and damage which may be caused in the event of fire.

### **4.11.2 Specific Requirements**

The choice of plant and design of the installation is to meet the following criteria:

- (a) Sub-station layouts are to utilize the minimum of land area in the existing Substation.
- (b) All equipment is to facilitate the installation of all circuits indicated as "future" with the minimum of disruption. All cabling schemes, D.C. and A.C. equipment etc. shall be designed to accommodate all such future circuits and loads.

- (c) The plant and installation shall be designed for a minimum service life of 25 years.
- (d) All plant is to have a minimum of 2 years satisfactory and proven service record of high durability and reliability in a similar environment. Documentary evidence in support of the choice of any item of plant shall be provided by the Contractor if requested by the Project Manager.

Each sub-station is to be designed such that the failure or removal of any one item of plant for maintenance or repair shall not damage or hamper the operational integrity of the sub-station. The design and layout of the sub-stations shall ensure the safety of personnel concerned with the operation and maintenance of the plant.

## **4.12 Plant and Equipment Identification**

### **4.12.1 Identification on Drawings**

The Contractor shall prepare comprehensive plant and equipment Identification Schedules. Each item in the Schedules shall include the drawing number of the related flow sheet, diagram or drawing showing that item.

### **4.12.2 Labels and Nameplates**

The Contractor shall supply and install labels, nameplates, ratings, instructions and warning plates, necessary for the identification and safe operation of plant and equipment at Substations.

Nameplates and labels shall be non-hygroscopic material with engraved lettering of a contrasting colour or, alternatively in the case of indoor circuit-breakers and starters, of plastic material with suitably coloured lettering engraved thereon.

All nameplates and labels shall be securely fixed to items of plant and equipment with stainless steel rivets, plated self-tapping screws or other approved means. The use of adhesives shall not be permitted.

Individual plant items and all relevant areas within the contract works where a danger to personnel exists shall be provided with plentiful, prominent and clear warning notices. These warning notices shall draw attention to the danger or risk with words which attract attention and summarize the type of risk or danger. The notices shall also carry a large symbol which graphically depicts the type of risk.

All equipment within panels and desks shall be individually identified. The identification shall correspond to that used in schematic and wiring diagrams.

Each circuit breaker panel, electrical control panel, relay panel etc., shall have circuit designation label mounted on the front and rear. Corridor type panels shall additionally have circuit designation labels within the panels.

All equipment and apparatus mounted there on shall be clearly labeled in an approved manner. The function of each relay, control switch, indicating lamp, MCB, link etc. shall be separately labeled.

The Contractor shall be responsible for the relocation, or replacement of all labels on existing plant, which becomes inaccurate as a consequence of the contract works.

The language of labels, plates and notices shall comply with the requirements of the Contract.

## **4.13 Safety and Security**

### **4.13.1 Interlocks**

A complete system of interlocks and safety devices shall be provided so that the following requirements and any other condition necessary for the safe and continuous operation of the plant are provided:

- (a) Safety of personnel engaged on operational and maintenance work on the plant.
- (b) Correct sequence of operation of the plant during starting up and shutting down periods.
- (c) Safety of the plant when operating under normal or emergency conditions.
- (d) Interlocks shall be preventive, as distinct from corrective in operation.

Where plant supplied under this Contract forms the whole or a part of a system for which one or more interlocking schemes are required, the Contractor shall be responsible for designing all interlocking schemes and presenting them for the Project Manager's approval. General descriptions of interlocking requirements are given in the Specifications but the Contractor shall include for any other interlocks he considers necessary.

### **4.13.2 Locks, Padlocks, and Key Cabinets**

The Contractor shall provide padlocks, locks, chains or other locking devices for the locking of all equipment cubicles, electrical isolating switches, selector switches, valves, etc. to the approval of the Project Manager.

All locking devices and chains shall be manufactured from corrosion resistant material. All mechanisms shall be provided with a cover to minimize entry of water or dust.

Locks shall conform to a master keying feature system to be agreed with the Project Manager for groups of equipment. All locks shall have individual high integrity locks and shall be provided with three (3) keys. Each key shall be provided with a label as specified.

The Contractor shall supply and fit key cabinets equipped with labeled hooks, each identified with its appropriate key. Every cabinet shall be provided with a nameplate identifying the cabinet with its respective item or items of plant. Sufficient cabinets shall be provided to store all keys supplied under this Contract and cater for future extensions.

The Contractor shall provide comprehensive lock and key schedules to readily permit identification with equipment and doors. Such schedules are not required for loose padlocks.

Where modifications are performed to existing sites the Contractor shall provide a system identical to that existing.

#### **4.14 Commissioning Spares**

In addition to the spare parts being provided to the Employer, the Contractor is responsible for ensuring that he has access to a stock of commissioning spares. Spares provided to the Employer are not to be utilized as commissioning spares without written approval of the Project Manager, in which case the Contractor shall immediately replace the contract spares at his own expense.

All commissioning spares are considered as Contractor's equipment.

#### **4.15 Consumable Items**

##### **4.15.1 Chemicals and other Consumable**

The Contract includes for the provision of all chemicals, resins, and other consumables required for testing, commissioning and setting to work of each section of the works.

Unless otherwise stated, the Contractor shall provide all such chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period of 12 months for each section of the works from the date of the final certificate.

The Contractor shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

#### **4.16 Painting and Cleaning**

Immediately following signing of the contract, the Contractor shall submit the names of the proposed paint supplier and applicator together with a quality assurance program for approval. All paints for a contract shall be provided by one manufacturer and preferably shall be manufactured in one country to ensure compatibility.

Painting of the plant shall be carried out in accordance with the appropriate schedule. The work is generally covered by the schedules but where particular items are not referred to specifically, they shall be treated in a manner similar to other comparable items as agreed with the Project Manager.

The schedules indicate standards of surface preparation and painting which is intended to give a minimum service life of 10 years in a coastal industrial environment, with need for minor remedial work only during that period.

Steel sections and plate shall be free from surface flaws and laminations prior to blast cleaning and shall not be in worse condition than Pictorial Standard B, Swedish Standard SIS 05 5900.

The Project Manager will consider alternative paint schemes to meet the requirements of fabrication using modern automated materials handling systems, provided they offer the same standards of surface protection and service life as those intended by the schedules.

All paints shall be applied by brush or spray in accordance with the schedule, except for priming coats for steel floors, galleries and stairways where dipping is permitted.

Where paint is to be applied by spray, the applicator shall demonstrate that the spray technique employed does not produce paint films containing vacuoles.

Where paint coatings are proposed for the protection of surfaces of equipment exposed to corrosive conditions, such as plant items exposed to brines or sea water immersion in liquid, or wet gases, the coatings shall be formulated to the suitably corrosion resistant and shall be high voltage spark tested at works and/or at site prior to commissioning. The test procedure shall be based on the use of a high voltage direct current. The voltage used shall be 75% of the breakdown voltage of the coating. This breakdown voltage shall first be separately determined using test plates coated with the specified coating formulation and thickness. The coating on the test plate shall also be micro-sectioned by the applicator to show that it is free from vacuoles and other defects likely to invalidate the test procedure.

If the defects revealed by the above test procedure do not exceed one per 5 m<sup>2</sup> of coating surface, the coating need not be re-tested after the defects have been repaired. If the defects exceed one per 5 m<sup>2</sup> of coating surface, the repairs shall be resettled after any curing is completed, and this procedure shall be repeated until the defects are less than one per 5 m<sup>2</sup> of coating surface. After repair of these defects, the equipment can be placed in service without further testing.

All coating proposed for the internal protection of domestic water storage tanks and shall be certified by an approved independent Authority as suitable for use in potable water installations and shall meet the non-painting requirements of BS 3416.

All planished and bright parts shall be coated with grease, oil or other approved rust preventive before dispatch and during erection and this coating shall be cleaned off and the parts polished before being handed over.

Where lapped or butted joints form part of an assembly which is assembled or part assembled prior to final painting, the jointed surfaces shall be cleaned free from all scales, loose rust, dirt and grease and given one brush applied coat of zinc phosphate primer before assembly.

Paint shall not be applied to surfaces which are superficially or structurally damp and condensation must be absent before the application of each coat.

Painting shall not be carried out under adverse weather conditions, such as low temperature (below 40° C) or above 90% relative humidity or during rain or fog, or when the surfaces are less than 30° C above dew point, except to the approval of the Project Manager or his duly appointed representative.

Priming coats of paint should not be applied until the surfaces have been inspected and preparatory work has been approved by the Project Manager or his duly appointed representative.

No consecutive coats of paint, except in the case of white, should be of the same shade. Thinners shall not be used except with the written agreement of the Project Manager.

On sheltered or unventilated horizontal surfaces on which dew may linger more protection is needed and to achieve this additional top coat of paint shall be applied.

The schedules differentiate between 'Treatment at Maker's Works' and 'Treatment at Site after Completion of Erection' but the locations at which different stages of the treatments are carried out may be modified always providing that each change is specifically agreed to by the Project Manager and the painting is finished at site to the Project Manager's satisfaction.

All paint film thickness quoted are minimum and refer to the dry film condition. All thickness shall be determined by the correct use of approved commercial paint film thickness measuring meters.

The Contractor shall ensure that precautions are taken in packing and crating to avoid damage to the protective treatment applied before shipment, during transport to the site.

Structural bolts shall be galvanized, sherardized or cadmium plated and painted as for adjacent steelwork.

All structural timber that does not require to be painted (timber joists, flooring, etc.) shall be treated with two coats exterior grade approved timber preservative.

The requirements of this clause and the schedules shall be interpreted in accordance with the requirements and recommendations of BS 5493 and CP 231, 3012 and the paint manufacturer's special instructions where applicable.

Colour shall be in accordance with BS 1710 and BS 4800 or equivalent national standards.

#### **4.17 Galvanized Work**

All galvanizing shall be carried out by the hot dip process and unless otherwise specified, shall conform in all respects with IEC's.

Attention shall be paid to the detail of members, (in accordance with IEC's). Adequate provision for filling venting and draining shall be made for assemblies fabricated from hollow sections. Vent holes shall be suitably plugged after galvanizing.



All surface defects in the steel, including cracks, surface laminations, laps and folds shall be removed (in accordance with IEC's). All drilling cutting, welding, forming and final fabrications of unit members and assemblies shall be completed before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from welding slag, paint, oil, grease and similar contaminants.

The coating shall be as specified in BS EN ISO 1461 or equivalent National standard. Structural steel items shall initially grit blasted to BS 4232, second quality (SA2.5). The minimum average coating weight on steel sections 5 mm thick and over shall be as specified in BS EN ISO 1461.

Bolts, nuts and washers, including general grade high strength friction grip bolts (referred to in BS 3139 and BS 4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to BS 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of a galvanized high strength friction grip bolt after the bolt has been inserted through the steelwork shall be allowed to come into contact with the faying surfaces.

During off-loading and erection, nylon slings shall be used. Galvanized work which is to be stored in works on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (with rust).

Small areas of the galvanized coating damaged in any way shall be brought to the attention of the Project Manager who shall authorize repair by cleaning the area of any weld slug and through wire brushing to give a clean surface, and application of two coats of zinc rich paint or the application of low melting point zinc alloy repair rod or powder to the damage area, which is heated to 300<sup>0</sup>C.

After fixing, bolt heads, washes and nuts shall receive two coats zinc rich paint.

#### **4.18 Steel Pipe Work**

All steel piping shall be designed, manufactured and tested in accordance with British Standards or equivalent National Standards approved by the Project Manager. In particular, the minimum wall thickness of steel pipe work shall comply with Table 2 of BS 1387.

Drains and air vents shall be provided as required by the physical arrangement of the pipe work and shall be via valves with the drain and vent pipe work led to drain points to the approval of the Project Manager.

Screwed pipe work systems shall be provided with adequate unions to enable valves and fittings to be removed if required with minimum disturbance to the rest of the pipe system.

#### **4.19 Bolts, Studs, Nuts and Washers**

All bolts and nuts shall conform dimensionally to the requirements of BS 3092 or BS 4190 or equivalent National Standard.

The Material of all bolts, studs and nuts for piping systems shall conform to the requirements of BS 4505 or equivalent National Standard.

The threaded portion of any bolt or stud shall not protrude more than 1.5 threads above the surface of its mating nut.

When fitted bolts are used they shall be adequately marked to ensure correct assembly.

Bolts, nuts, studs and washers in contact with sea water or used on pipe work systems containing sea water shall be of the same material as flanges etc.

The use of slotted screws shall be avoided; hexagon socket screws or recessed type heads shall be used.

## **4.20 Architectural and Structural Requirements of Buildings**

### **4.20.1 Architectural Planning and Design**

All new buildings and extension to existing buildings shall be designed to be architecturally pleasing in appearances to the satisfaction of the Employer and to withstand the tropical climate with minimal maintenance.

Architectural plan and elevations of all sides of buildings shall be agreed with the Project Manager before other details are finalized. All external walls shall be 230 mm first class brick work plus a 50 mm thick layer of Mirpur ceramics facing bricks or similar approved for new sub-station building as required by the architectural drawing. The internal walls shall be 105 mm thick first class brick work with plastered and painting of an approved color.

Bath room floors, walls and stairs shall be tiled by BISF/AKIJ/RAK/CARU/Equivalent. A fixed ladder of galvanized steel shall be provided up to the roof considering the future provision. Window frames shall be aluminum with MS grill. Doors shall be wooden and water proofed as approved by the project office. A rolling shutter door with a ramp shall be provided for 10 MVA Substation buildings.

The main entrance to all buildings shall be shaded, either by a projection of the roof over the entrance verandah or by a separate roof at a lower level. This area of roof shall also be lime terraced and drained by rainwater pipes.

The service facilities like electricity, water supply and sanitary works, sewerage, gas connection (if possible) etc. shall be provided as per requirements. Best quality fitting and fixture made in Bangladesh as approved by project office shall be provided in bathroom in kitchen room. Electrical fittings and fixtures shall be best quality and wiring provided in Substation buildings shall be internal. Samples shall be shown to and approved by the Project Manager.

### **4.20.2 Structural Design**

Structural design of Substation buildings shall be according to the Bangladesh National Building Code (BNBC). Loads for reinforce concrete design shall be calculated as the sum of dead loads, live loads and environmental loads (wind and seismic) as explained in the BNBC. Ultimate Strength Design (USD) method (BNBC Chapter 6) shall be adopted for design of all reinforce concrete structural elements.

The roof shall be a cast in situ concrete slab designed for  $2.5 \text{ kN/m}^2$  live load. The ground floor slab shall be cast as per cable trench layout which shall be considered as slab on grade (RBC floor).

#### **4.21 Utility Services**

Utilities shall be designed and installed comprising:

- (a) Plumbing system including wastewater and surface water drainage system development including septic tank, soak well, and surface or buried drain. Surface water drainage system shall be RCC.
- (b) Water supply and sanitary work.
- (c) Electrical works includes internal wiring, fitting, fixing all necessary items, internal lighting, street lighting, CCTV and necessary earthing.
- (d) Telephone if needed. Supply and installation of internet cable for high speed internet connection shall be done with internal wiring

#### **4.22 Fire Detection and Protection Facilities**

The Contractor shall design, manufacture, deliver to the Site, install, test and commission the firefighting system to protect each Substation, all plant associated equipment and outdoor yard. In particular, the following shall be included:

- (a) Fire Detection and Alarm system: fire detection shall be by means of smoke detectors and ultra violet flame detectors with a backup system utilizing rate-of-rise temperature detectors, along with an alarm system.
- (b) Balancing, testing and commissioning of fire detection and alarm system for 16 zone.
- (c) Dry chemical powder and carbon dioxide type fire extinguishers.
- (d) Five wall mounted sand buckets outside the control room building at suitable place locations

A reinforced concrete fire wall is required between two transformers in future provision for 10 MVA substations. The wall size shall depend on the transformer size. The Contractor shall prepare proposed designs for approval of the Project Manager.

#### **4.23 Grid Substation Sending End Bays for New Substations**

Some of the new Substations shall have direct connections from grid substations. Bays and busbar must be available for facilitating this connection. Where existing bay and busbar space is not available, new bays shall have to be designed and constructed and the existing busbar extended.

The Contractor shall be responsible for designing and constructing the grid substation foundation for 33KV circuit breaker, CT, gantry extension to construct new feeder bays and bays extension including earth grid where required including installing bay equipment and associated works. The design and drawings shall be submitted for the Project Manager's approval before any work commences at site.

#### **4.24 Preparation of the Site**

Boundary pillars of standard designs shall be fixed on the ground to define the boundary of the site.

Refuse or superfluous earth on the site shall be removed before construction begins. Shrubs and stumps of trees shall be uprooted and removed off site. Any valuable material derived from the clearing of the site should be stored and disposed of according to the BNBC.

No tree shall be cut down or pruned unless prior approval is given by the Project Manager. A survey report must be submitted and sanctions obtained before the trees are disposed of. If white ants are found to exist in the trees, their nests shall be located and dug up and the queen ant be destroyed. Holes left after uprooting of the trees shall be backfilled with sand or earth, care being taken that the fill, on compaction, achieves the density of the surrounding soil.

The Contractor's Engineer himself shall set out all important levels for permanent works using the site benchmark established during the topographical survey. Areas for storage and stacking of materials should be set out and pegged, similarly the position of temporary buildings, the access road and site roads.

The Contractor shall not fell any tree outside the site boundary without the express written permission of the land possessor, even if such tree is an obstacle to execution of the work.

#### **4.25 Temporary Buildings on Site**

Locations of temporary offices, guard sheds, work sheds and accommodation on each site shall be selected such that they do not clash with the location of permanent work and do not interfere with construction work. Prefabricated buildings that are simple to erect and dismantle, yet provide a pleasing look, are preferred.

#### **4.26 Access to the Site**

The access road to each site shall generally be of the shortest possible length from the nearest main road. While designing the road alignment, the Contractor shall maximize natural slopes as much as possible for drainage of rainwater and the facilities shall be secured effectively and economically. The design and drawings shall be prepared by the Contractor to current practices AASHTO codes of practice.

#### **4.27 Site Drainage**

The entire surface of each Substation site within its boundary walls shall slope at 1 in 150 minimum gradient to open channels around the entire perimeter. These channels shall be designed for a rainfall intensity of 60 mm per hour. Outside the boundary wall, the Contractor shall be responsible for drainage up to 20 meters, or to suit each sites requirements, from the wall and the drainage outlets at some sites may be need to be provided with suitable erosion protection down to paddy level.

The ground immediately adjacent to foundations shall be sloped away from them at a slope of not less than 1:12 for a minimum distance of 205 m measured perpendicular to the toe of the wall. Consideration shall be given to possible additional settlement of backfill when establishing the final ground level adjacent to foundation.

A 75 mm layer of crushed rock (average size 30 mm) shall be placed across the entire site, extending 1 m outside the fence.

The concrete wall of cable trenches shall project at least 70 mm above brick paving level to prevent run off entering the cable trench. The floors of all cable trenches or tunnels shall be sloped to soak aways.

The cable trenches shall be free from surface water drainage. If the cutoff area exceeds 30 m<sup>2</sup> it shall be drained by a concrete pipe sized to take the runoff to the boundary drain. The Contractor's drainage design shall avoid all ponded water to avoid forming a mosquito breeding ground.

All drainage pipe work except cable trenches within buildings shall be UPVC pipe of diameter as per design requirement. But cable trenches are RCC work as per design requirements.

The floor slab shall be constructed in reinforced brick concrete (RBC) floor 125 mm thick and foundations for controlling equipment in RCC.

External pipe work shall be 150 mm minimum diameter concrete pipes at a minimum depth of invert of 600 mm. Where pipes, including existing pipes along with site, are less than 400 mm above adjacent foundations, they shall be surrounded in concrete. Where required, drainage pipes shall be kept below cables, allowing 1.1 m cover to the top of pipes.

Manholes shall be of brick construction with 500mm x 500mm clear openings and air tight ductile iron covers to BS EN 124. Manholes shall be located at all changes of pipeline direction. The minimum gradient for all pipelines shall be 1 in 80. Manholes shall not be located in roads.

The Contractor shall be responsible for all negotiations with local authority (WASA) where a connection to a public sewer is proposed. The Contractor shall provide all protection required to existing sewers and shall deepen foundations, including boundary wall foundations, where required all foundations are below adjacent sewers.

Each control building shall be provided with a septic tank designed for 10 users and a soakaway of open brick construction 11 m deep by 2.2 m diameter filled with broken bricks. The septic tank shall be located at suitable place of the area. The inner surface of all manholes and septic tanks shall be painted with two coats of bitumastic paint to protect it against sulphate attack. The septic tank shall have access holes directly over the inlet pipes and outlet pipes. Where public sewers exist along the side of substation site, the Contractor shall connect directly to the sewerage line from the soak away. Two vents of minimum height 2.2 m shall be provided on each septic tank.

#### **4.28 Site Maintenance during Construction**

- a) The site shall be kept as clean as reasonably possible during construction.

**Materials shall not be stacked haphazardly but kept in a planned manner in**

proper stacks. Care shall be taken to maintain the site with proper drainage of rain and stagnant water.

- b) The proposed roads should be laid out and used for carriage of materials to avoid vehicles travelling randomly over the site and spoiling it. The base of the road may also be laid and maintained during construction.
- c) Any rejected materials, dismantled materials and other items not required in the construction shall be removed from the site immediately, so that there is no chance of it being used by the Contractor's labour.

## B. CIVIL

## 5.0 SUBSTATION BUILDINGS AND ANCILLARY FACILITIES

### TABLE OF CONTENTS

| Clause No. | Description                                                                |
|------------|----------------------------------------------------------------------------|
|            | Civil Works-General                                                        |
| 5.1        | Mobilization and Preparation of the Site                                   |
| 5.2        | Dismantling & Removal of Existing Structures for Rehabilitation Sites Site |
| 5.3        | Office Facilities for the Engineer                                         |
| 5.4        | Earth Work in Excavation For Structure Brick                               |
| 5.5        | Flat Soling (BFS)                                                          |
| 5.6        | Lean Cement Concrete (CC) Works Cement                                     |
| 5.7        | Concrete In Floor                                                          |
| 5.8        | Damp Proof Course                                                          |
| 5.9        | Reinforced Cement Concrete Work (RCC)                                      |
| 5.10       | RCC with Water Proofing Admixture                                          |
| 5.11       | Reinforcing Steel In Concrete                                              |
| 5.12       | Brick Work                                                                 |
| 5.13       | Patent Stone Flooring                                                      |
| 5.14       | Ceramic Tiles                                                              |
| 5.15       | Plaster Work                                                               |
| 5.16       | Neat-Cement (Skirting/Dado)                                                |
| 5.17       | Making Groove On Wall Surface                                              |
| 5.18       | Painting Works                                                             |
| 5.19       | Timber Works                                                               |
| 5.20       | Metal Works                                                                |
| 5.21       | Aluminum Doors, Windows etc.                                               |
| 5.22       | Water Proofing Polythene Sheet                                             |
| 5.23       | Lime Terracing on Roof Screeding                                           |
| 5.24       | on Roof                                                                    |
| 5.25       | Surface Drain                                                              |
| 5.26       | Apron                                                                      |
| 5.27       | Road Work                                                                  |
| 5.28       | Clearing after Completion As                                               |
| 5.29       | Built Drawings                                                             |
| 5.30       | Tests for Materials                                                        |
| 5.31       |                                                                            |

## 5.1 Civil Works-General

This specification has been prepared with all possible care and diligence and every effort has been made to cover all types of materials and items of works necessary to complete the Project in all respect.

All workmanship and materials to be used in the Works shall be of the best quality of their respective kinds as specified herein. All materials used in the Works shall be new and obtained from the sources and suppliers approved by the Project Manager. Materials shall comply strictly with the requirements prescribed hereinafter or, where such requirements are not specified in this specification, the latest issues of the relevant Technical Standard shall be followed. All tests of materials shall be done by laboratory approved by the Project Manager. The accuracy and sufficiency of information furnished in this specification is not guaranteed. It is the responsibility of the Contractor to clear any confusion or ambiguity in this specification well ahead of submission of bid. In case of any missing item relevant standard specification shall be followed.

### 5.1.1 Materials

#### 5.1.1.1 Cement

Cement shall be Ordinary Portland Cement conforming to the requirements of the Standard Specifications for Portland Cement Type -I, ASTM C-150 or BDS 232 (2nd Revision) unless otherwise specified.

Cement shall conform to the following standards as per BDS 232 (2nd Revision) and ASTM C109, C191, C204.

- |                                    |   |                                                    |
|------------------------------------|---|----------------------------------------------------|
| a) Water for normal consistency    | : | 26% to 33%                                         |
| b) Fineness                        | : | Minimum 280 sq. m./kg (by air permeability method) |
| i) Initial setting time, ASTM C191 | : | Not less than 45 min.                              |
| ii) Final setting time, ASTM C191  | : | Not less than 375 min.                             |
| c) Minimum compressive strength    | : | 9.45 Mpa (1350 psi)                                |
| i) 3 <sup>rd</sup> . day           | : | 14.7 Mpa (2100 psi)                                |
| ii) 7th day                        | : | 21.0 Mpa (3000 psi)                                |
| iii) 28th day                      | : |                                                    |

Cement shall be delivered in packages as packed by the Manufacturer with the brand name, type of cement and weight of each bag marked on the bag. Sample test of cement must be done by laboratory approved by the Project Manager: Two bags from each brand or each consignment of supply of 25 metric tons of cement shall be selected for testing. The Project Manager require the Contractor to have the cement tested or can take samples in the presence of Contractor from cement bags stored at work site and send them to an approved laboratory for testing.



Cement of doubtful quality shall not be used until satisfactory results are obtained. All cement not conforming to specifications and cement that has deteriorated, been damaged or has set shall not be used and shall be immediately removed from work site by the Contractor. The cost of all such cement shall be borne by the Contractor.

### **5.1.1.2 Brick**

Common building clay bricks shall conform to BDS 208 (First Revision).

Bricks shall be manufactured from combination of clay mixed with silica sand and alumina and shall be uniformly burnt throughout. Bricks shall be kiln burnt.

### **First Class Bricks**

First Class Bricks shall comply with the following requirements of BDS 208 (Common Building Clay Bricks –First Revision)

- a) Bricks shall be of machine mould, uniform colour, shape and size having sharp square sides and edges and paralleled faces.
- b) Bricks shall be sound, hard and well burnt homogeneous in texture and free from flaws and cracks.
- c) Bricks shall emit a clear metallic sound when struck with a small hammer or another brick. A fractured surface shall show a uniform compact structure free from lumps, grits or holes.
- d) A first class brick shall not absorb more than  $1/5^{\text{th}}$  of its dry weight when immersed in water for 24 hours.
- e) A first class brick shall not break when struck against another brick or when dropped at T-position on hard ground from a height of about 1.2 meter.
- f) Standard dimension of bricks shall be 240 x 115 x 70mm (9.5" x 4.5" x 2.75")
- g) Allowable variations in dimensions shall be:
  - i) in length not more than 6 mm
  - ii) in breadth not more than 5 mm
  - iii) in height not more than 1.5 mm
- h). Unit weight of bricks shall be minimum 1100 kg/cum
  - i) Minimum compressive strength of bricks shall be for
    - i) Halved bricks (mean of 12 bricks): 28 Mpa (4000 psi)
    - ii) Individual brick: 21.1 Mpa (3000 psi)
- j). Range of efflorescence for a first class brick shall be slight to nil.

### **Picked Jhama Bricks**

Picked Jhama-Bricks shall be over-burnt First Class Bricks, uniformly vitrified throughout with good shape, hard slightly black in colour, and without cracks or spongy areas. Minimum compressive strength shall not be less than 28 N/mm<sup>2</sup> (4000 psi)

All other requirements for First Class Bricks shall apply to Picked Jhama except for dimensions.

## Perforated Bricks

Perforated bricks shall meet the following specifications:

- (a) Minimum unit weight : 3.00 kg/brick
- (b) Minimum compressive strength on gross area::
  - i) Multi-core brick : 70kg/sq.cm
  - ii) 10-Hole engineering brick : 210kg/sq.cm
  - iii) Maximum size of perforation : 25sq.mm
- (c) Minimum number of perforations :
  - i) Along width of brick : 2
  - ii) Along length of brick : 6
- (d) Minimum wall thickness:
  - i) Between brick edge and perforation : 10mm
  - ii) Between adjacent perforations : 10mm
- (e) Maximum water absorption :
  - i) 5hrs, boiling : 20% of dry wt.
  - ii) Efflorescence : Nil

Dimensions (3mm) 24cm × 11cm × 7cm (9.5" × 4.5" × 2.75")

The perforations may be of any regular shape in cross section, In case of rectangular section the larger dimension shall be parallel to length of the brick. Dimension of perforation measured parallel to the plane of the shorter side shall not be more than 15cm except in case of circular shape of the perforation in which case it may be allowed up to 20 cm. Total area of perforation shall not exceed 45% of the total area of corresponding face of the brick.

## Clinker Bricks

Clinker bricks or tiles shall meet the following requirement:

|                           |         |   |                        |
|---------------------------|---------|---|------------------------|
| Minimum unit weight       | Minimum | : | 2 kg/brick             |
| compressive strength      | Minimum | : |                        |
| modulus of rupture        | Water   | : | 560 kg/sq.cm (8000psi) |
| absorption 5 hrs. boiling |         | : | 560 kg/sq.cm (600psi)  |
| Efflorescence             |         | : | 12%-15% of dry wt.     |
| Dimensions                |         | : | Nil                    |
|                           |         | : | 200 mm x 100 mm x 5 mm |
|                           |         | : | (8" × 4" × 2")         |

Clinker bricks shall be manufactured by dry process and burnt to a higher temperature and shall uniformly vitrified to a dark copper tone. Edges shall be square, straight and sharply defined.



### 5.1.1.3 Sand (Fine Aggregate)

Sand shall conform to BDS 243, ASTM C 33

Sand shall be either natural sand, composed of clean, hard, durable uncoated particles resulting from the disintegration of siliceous and/or calcareous rocks; or manufactured sand resulting from the crushing of boulders or shingle.

The maximum size of the particles shall be 4.75 mm (3/16 in) and shall be graded down.

Sand shall be clean and free of injurious amounts of organic impurities; deleterious substances shall not exceed the following percentages by weight:

|                                              |                      |
|----------------------------------------------|----------------------|
| Clay Lumps and friable particles-Maximum     | 3%                   |
| Coal and Lignite                             | 0.25%                |
| Material passing the 0.075mm (No. 200) sieve | 1%                   |
| Shale, coal, soft or flacky fragments        | 1%                   |
| Sulfur compounds                             | 0.3%                 |
| Organic material content                     | no organic material. |

Sand shall be well graded from coarse to fine and shall conform to the following Fineness

Modulus:

|              |   |     |                    |
|--------------|---|-----|--------------------|
| Concrete     | : | 2.5 | (Two point five)   |
| Concrete     | : | 1.5 | (One point five)   |
| Mortar       | : | 1.5 | (One point five)   |
| Filling sand | : | 1.0 | (One point zero)   |
|              | : | 0.8 | (Zero point eight) |

Sand from different sources of supply shall not be mixed and stored in the same stock pile nor used alternately in the work without permission from the Project Manager.

#### 5.1.1.4 Coarse Aggregate

Coarse aggregate shall conform to BDS 243 (Coarse and Fine Aggregates from Natural Sources for Concrete 1; ASTM C 33: Concrete Aggregates).

Nominal maximum size of coarse aggregate in concrete shall not be larger than:

- a) One-fifth of the narrowest dimensions between sides of forms; or
- b) One-third the depth of slabs; or
- c) Three-fourth the minimum clear spacing between individual reinforcing bars or wires, bundles of bars.

#### The Boulder

The boulders to be used for coarse aggregate in concrete shall be composed of limestone, sandstone, granite, trap rock or rock of similar nature and shall have the following properties.

|                                |   |                 |
|--------------------------------|---|-----------------|
| Compressive strength (minimum) | : | 35Mpa (5000psi) |
| Specified gravity              | : | 2.2-2.6         |
| Unit weights                   | : | 22-25.1 kn./cum |
| Porosity                       | : | 2.10%           |
| Water absorption (maximum)     | : | 5% by wt        |

The boulder shall be of uniform light color as approved and shall be free of thin laminations, adherent coatings, and deleterious substances. The wear loss of coarse aggregate of all types shall not exceed 35% by weight when tested by the Los Angeles Abrasion Test.

#### 5.1.1.5 Water

The water used in mixing and curing concrete shall be tested for chlorides and sulphates in a standard material-testing laboratory as directed by Project Manager. The maximum acceptable limits shall be as follows:

1000mg/l as SO<sub>3</sub> for sulphates  
500mg/l as Cl ion for chloride

Water shall be clear and free from salt, oil or acid, vegetable or other substances injurious to the finished product. The pH values of water shall generally be not less than 6. Water used in construction work shall be potable.

#### 5.1.1.6 Admixtures

Admixtures used for the purpose of modifying the normal plastic life of concrete mix or for influencing its rate of gaining hardness and strength or for the workability of concrete shall not be used except with the written approval of the Project Manager.

Admixture if specified or permitted shall conform to the requirements of AASHTO Standard Specification M-194/ASTM, C-494 or ASTM C-1017.

It shall be kept in mind that a small change in the amount of admixture may cause great change in their action and their adequacy of performance is difficult to measure at the construction site during the progress of work. Water reducing admixture, accelerating admixture, water reducing and retarding admixtures, water-reducing and accelerating admixtures shall conform to ASTM C-494 (Chemical Admixtures for Concrete) or ASTM C-1017 (Chemical Admixtures for use in producing flowing Concrete)

#### 5.1.1.7 Reinforcing Bar

High tensile steel reinforcing bar shall be structural grade deformed bar specified as per ASTM, A615M, and BOS 1313: 91, Bars having minimum yield levels of 275 Mpa (40,000 psi) and 415 Mpa (60,000 psi) are designated as Grade 40 and Grade 60 respectively. High tensile steel reinforcing bars shall meet the following strength test requirements:

| Properties                  | Grade 40               | Grade 60               |
|-----------------------------|------------------------|------------------------|
| Yield strength (minimum)    | 275 Mpa<br>(40000 psi) | 415 Mpa<br>(60000 psi) |
| Ultimate strength (minimum) | 483 Mpa<br>(70000 psi) | 620 Mpa<br>(90000 psi) |

#### Tolerance on Mass

| Nominal size (mm) | Tolerance of mass per Meter run (%) |
|-------------------|-------------------------------------|
| Up to 7           | □ 8.0                               |
| 8 to 12           | □ 6.0                               |
| Over 12           | □ 4.5                               |

#### Tolerance on Diameter

Tolerance in diameter for both plain and deformed bars shall not exceed 2.5% for 12mm and less size and 1.8% for sizes larger than 12 mm.

## Tensile Requirements

|                            |                            | Grade 40 | Grade 60 |
|----------------------------|----------------------------|----------|----------|
|                            | Tensile strength, min. psi | 70000    | 90000    |
|                            | Yield strength min. psi    | 40000    | 60000    |
|                            | Elongation in 8 in min. %  |          |          |
| Bar Nos.                   |                            |          |          |
| 3 (10mm)                   |                            | 11       | 9        |
| 4 ,5, 6 (12, 16, 20 mm)    |                            | 12       | 9        |
| 7, 8 (22, 25 mm)           |                            | ...      | 8        |
| 9, 10 (28, 32 mm)          |                            | ...      | 7        |
| 11, 14, 18 (35, 45, 57 mm) |                            | ...      | 7        |

## Bending Requirements

The bend-test specimen shall withstand being bent around a pin without cracking on the outside of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in Table 3 -Bend Test Requirement.

The bend test shall be made on specimens of sufficient length to ensure free bending and with apparatus which provides.

- ☐ Continuous and uniform application of force throughout the duration of the bending operation.
- ☐ Unrestricted movement of the specimen at points of contact with the apparatus and bending around a pin free to rotate.
- ☐ Close wrapping of the specimen around the pin during the bending operation.

## Bend Test Requirements

| Bar Designation No.                                                                                               | Pin diameter for Bend Test <sup>A</sup> |                  |
|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------------|
|                                                                                                                   | Grade 60                                | Grade 40         |
| 3,4,5                                                                                                             | $3\frac{1}{2} d^b$                      | $3\frac{1}{2} d$ |
| 6                                                                                                                 | 5d                                      | 5d               |
| 7,8                                                                                                               | 5d                                      | --               |
| 9,10                                                                                                              | 7d                                      | --               |
| 11                                                                                                                | 7d                                      | --               |
| 14,18 (90 <sup>0</sup> )                                                                                          | 9d                                      | --               |
| Test <sup>A</sup> bends 180 <sup>0</sup> unless noted otherwise.<br>d <sup>b</sup> = nominal diameter of specimen |                                         |                  |

### Frequency of Tensile, Bend, Rebend testing

| Nominal size of bar (mm) | Value of x (Quality of materials in tones) |           |             |
|--------------------------|--------------------------------------------|-----------|-------------|
|                          | Tensile test                               | Bend test | Rebend test |
| Under 10                 | 25                                         | 50        | 50          |
| 10 to 16                 | 35                                         | 70        | 70          |
| 20 to 32                 | 45                                         | 90        | 90          |

For the specified tests sample length shall be 600 mm long or 20 times the nominal size whichever is greater. Sample shall be selected from each batch at a frequency of not less than one up 5 (five) tones or part thereof where x has the value given in the above table. Samples from the bend and rebend tests shall not be selected from the same bar.

### Cross Sectional Area and Mass

| Nominal size | Mass (kg/m) | Cross sectional are (mm <sup>2</sup> ) |
|--------------|-------------|----------------------------------------|
| 6 mm         | 0.222       | 28.30                                  |
| 8 mm         | 0.395       | 50.30                                  |
| 10 mm        | 0.616       | 78.50                                  |
| 12 mm        | 0.888       | 113.00                                 |
| 16 mm        | 1.579       | 201.00                                 |
| 20 mm        | 2.466       | 314.00                                 |
| 22 mm        | 2.980       | 380.00                                 |
| 25 mm        | 3.854       | 491.00                                 |
| 28 mm        | 4.830       | 616.00                                 |
| 32 mm        | 6.313       | 804.00                                 |

All steel bars prior to its use shall be cleaned with wire brush to make it free from loose scale, dirt, paint, oil, grease or other foreign substances.

All reinforcing steel shall be stored properly under shed not to be contaminated by oil, grease or mud.

### Requirement for Deformation in Reinforcing Steel

The requirement of deformation shall meet ASTM A615.

- a) Deformations shall be spaced along the bar at substantially uniform distances. The deformations on opposite sides of the bar shall be similar in size and shape.
- b) The deformations shall be placed with respect to the axis of the bar so that the included angle is not less than 45<sup>0</sup> deg. Where the line of deformations forms an included angle



with the axis of the bar of from  $45^{\circ}$  to  $70^{\circ}$  deg inclusive. The deformations shall alternately reverse in direction on each side, or those on one side shall be reversed in direction from those on the opposite side. Where the line of deformation is over  $70^{\circ}$  deg. a reversal in direction is not required.

- c) The average spacing or distance between deformations on each side of the bar shall not exceed seventeenths of the nominal diameter of the bar.
- d) The overall length of deformations shall be such that the gap between the ends of the deformations on opposite sides of the bar shall not exceed 12.5% of the nominal perimeter of the bar. Where the ends terminate in a longitudinal rib, the width of the longitudinal rib shall be considered the gap. Where more than two longitudinal ribs are involved, the total width of all longitudinal ribs shall not exceed 25% of the nominal perimeter of the bar. Furthermore, the summation of gaps shall not exceed 25% of the nominal perimeter of the bar. The nominal perimeter of the bar shall be 3.14 times the nominal diameter
- e) The spacing/height and gap of deformations shall conform to the requirements prescribed in Table 1 of ASTM A615.
- f) Any bar that fails to satisfy the above requirements is to be treated as plain reinforcement according to ACI Building Code Requirements for Reinforced Concrete ACI 318-95.

#### 5.1.1.8 Timber for Doors/Windows

Timber for doors shall conform to BDS 142; specification for Wood Doors (under revision): BDS 820, Recommendation for maximum permissible moisture content of timber used for different purpose in Bangladesh.

Timber used for doorframe and leaf shall be well-seasoned, dry and straight grained, free from knots and other defects affecting its appearance, strength and durability. All timbers used for doors/windows shall be mechanically seasoned and the moisture content shall not be more than 12-13%.

#### 5.1.1.9 Aluminum Sections

All Aluminum Sections shall conform to U.S. Architectural Aluminum Manufacturers Association Standards (AAMA).

The following are the standards to be followed for Aluminum doors, windows and curtain walls or as specified in Bill of Quantity:

|                               |               |
|-------------------------------|---------------|
| Channel thickness for doors   | 1.8 -2.5mm    |
| Channel thickness for windows | 1.2 -1.8mm    |
| Anodization thickness         | 15 microns    |
| Density of anodization        | 4mg per sq.m. |

### 5.1.1.10 Glass

- ☐ Glass for aluminum door and window tinted or clear should be 5mm thick and there should be no undulations
- ☐ For smaller wooden panel/M.s. glazed shutters glass should be 3mm thick and there should be no undulations.

### 5.1.1.11 M.S. Pipe

M.S. pipe shall be made from low carbon steel conforming to ASTM A53 and following physical requirements:

| Nominal Pipe Diameter (mm) | Wall Thickness(mm ) | Inside Diameter (mm) | Outside Diameter (mm) | Weight (kg/m) |
|----------------------------|---------------------|----------------------|-----------------------|---------------|
| 150 mm                     | 7.11                | 154.08               | 168.30                | 28.26         |
| 100 mm                     | 6.02                | 102.36               | 114.40                | 16.07         |
| 75mm                       | 5.49                | 77.92                | 88.90                 | 11.29         |
| 50mm                       | 3.91                | 52.48                | 60.30                 | 5.44          |
| 25mm                       | 3.38                | 26.64                | 33.40                 | 2.50          |
| 20mm                       | 2.87                | 20.96                | 26.70                 | 1.69          |
| 12mm                       | 2.77                | 15.76                | 21.30                 | 1.27          |

### 5.1.1.12 UPVC Pipe

UPVC pipe shall be of Unplasticized Polyvinyl Chloride (UPVC) and shall conform to the following specifications:

|                      |   |                                               |
|----------------------|---|-----------------------------------------------|
| Specific Gravity     | : | 1.36 -1 .43                                   |
| Tensile strength     | : | $450 \text{ Kg/Cm}^2$ - $560 \text{ Kg/Cm}^2$ |
| Elongation           | : | 80%                                           |
| Compressive Strength | : | 600-700 $\text{Kg/Cm}^2$                      |

| <b>Nominal Size</b> |      | <b>Mean outside Diameter (MM)</b> |        | <b>Schedule 40 Wall Thickness (mm)</b> |      | <b>Schedule 80 Wall Thickness (mm)</b> |       |
|---------------------|------|-----------------------------------|--------|----------------------------------------|------|----------------------------------------|-------|
| Inch                | (mm) | Min                               | Mix    | Min                                    | Mix  | Min                                    | Mix   |
| 2.00"               | 50   | 60.17                             | 60.47  | 3.91                                   | 4.42 | 5.54                                   | 6.20  |
| 3.00"               | 75   | 88.70                             | 89.10  | 5.49                                   | 6.15 | 7.62                                   | 8.53  |
| 4.00"               | 100  | 114.07                            | 114.53 | 6.02                                   | 6.73 | 8.56                                   | 9.58  |
| 5.00"               | 125  | 141.05                            | 141.55 | 6.55                                   | 7.34 | 9.52                                   | 10.66 |
| 6.00"               | 150  | 168.00                            | 168.56 | 7.11                                   | 7.79 | 10.97                                  | 12.29 |
| 8.00"               | 200  | 218.70                            | 219.46 | 8.18                                   | 9.17 | 12.70                                  | 14.22 |

## 5.2 Mobilization and Preparation of the

### Site Description

This item shall consists of mobilization of man powers, materials & equipment and preparation of site by clearing off of the site of rubbish of all kinds including surplus earth, slurry, weeds, grass etc., cutting and uprooting of trees of all girth; removal of drains, dewatering & bailing out of water, during whole construction period, sewers or any other services, leveling of site including filling, if necessary, protection of the periphery of the site by earth to prevent passage of any outside rain and waste water etc. dismantling of existing structure if any, and removal of surplus materials and debris to a safe distance as directed by the Project Manager.

### Construction Requirement:

Before setting out the new work and commencing foundation work the site must be cleared off of all those described above. On clearance of site it should be roughly leveled as required.

The trees shall be cut and their roots totally up-rooted as directed by the Project Manager No tree should be cut unless it is absolutely unavoidable. All serviceable materials obtained from the clearing shall be property of the competent authority as determined by the Project Manager. Salvaged material may be handed over by the Contractor to the local authority on instruction from the Employer.

## 5.3 Dismantling & Removal of Existing Structures for

### Rehabilitation Sites Description

This item shall consists of the removal/ dismantling and satisfactory cleaning, stacking, storing or disposal, inside or outside the site of such portions of existing structures as provided in the Plans, Schedule of Quantities and Specifications or ordered by the Project Manager. This includes all items such as breaking and removal of khoa debris, concrete, R.C.C, brick work, plaster and other items as mentioned in schedule of quantity or as directed by the Project Manager.

## **Construction Requirement**

Before commencement of removal/ dismantling work, the structure or parts thereof shall be properly earmarked and necessary arrangement for stabilization of the adjoining structures shall be ensured by means of adequate shoring, shuttering, propping and strutting. The dismantling work shall not commence until the arrangement of safety of the adjoining structure has been insured by the Contractor, inspected and approved by the Project Manager. The Contractor shall be solely responsible for any damage to the portion of structure which were not intended to be dismantled and make good the damages, if any, at his own cost. The Contractor shall comply with all safety regulations and shall furnish, erect and maintain suitable barricades and warning signs and take such other measures as necessary to prevent personal injury or property damage. All these barricades, warning signs shall comply with the by-laws, regulations and provisions of BNBC and shall be to the satisfaction of Employer, and Local Authorities concerned.

This item of work also includes cleaning and sorting out of the salvaged materials in a usable condition, transporting and storing neatly for use/disposal as directed by the Project Manager. The items of dismantling works of different structures in foundation also include all excavation, bailing out water by pumping, drainage, bracing, shoring, etc. as found necessary and their subsequent removal and satisfactory disposal of all materials obtained from such excavations and backfilling to the level of original ground where required. The Contractor shall keep adequate records of all dimensional measurements of the structures and all other information relating to them as revealed and obtained during their work and have such measurements and information duly endorsed by the Project Manager at site. The work shall not start unless full measurement is recorded by the Project Manager. In some special cases, however, the recording may be done after dismantling.

The salvaged materials before or after dismantling shall be immediately measured and recorded in presence of the Project Manager and shall be in the custody of the Contractor until instructed to be disposed of by the Project Manager. Any loss of any dismantled material shall be recovered from the Contractor's bill at the recovery rate.

### **5.4 Site office Facilities for the Project Manager and**

#### **his Staff Description**

The Contractor shall provide and maintain temporary site office facilities during the construction period for the Employer and Consultant.

### **5.5 Earth Work in Excavation for**

#### **Structure Description**

The item shall consist of setting out true lines to all foundations for structures, performing the excavations to the required levels and grades in any kind of soil encountered, removing the spoils and backfilling of original ground line as provided in these specification or as directed by the Project Manager.

## **Construction Requirements**

The Contractor shall comply with all safety regulations and shall furnish, erect and maintain suitable barricades and warning signs and take such other measures as necessary to prevent personal injury or property damage.

### **5.5.1 Earth**

#### **Filling Description**

The item shall consist of filling any place or area, to make up levels, according to these Specifications and Plans with specified earth materials.

#### **Construction Requirements**

Silty Sand or other approved materials, free from large lumps, organic or other extraneous materials, shall be used for fill. Materials from excavation on the sites may be used as ordinary fill if it is approved.

The fill materials shall be deposited and spread in successive uniform horizontal layers of about 150 mm thick and compacted by use of mechanical 1.5 ton "Vibro" compactor or other approved devices to a 98% standard dry density in road and pavement sub-base and 95% standard dry density for other area.

Tests shall have to be carried out at recognized laboratory to ascertain the nature of the fill material and the degree of compaction obtained for the filled material for which samples have to be taken and transported by the Contractor at his expense and as directed by the Project Manager.

### **5.5.2 Sand**

#### **Filling Description**

The item shall consist of filling any place or area, to make up levels, according to these Specifications and Plans with specified and approved materials.

#### **Construction Requirements:**

Silty Sand or other approved materials, free from large lumps, organic or other extraneous materials, shall be used for filling. Materials from excavation on the sites may be used as ordinary fill if it is approved.

#### **Materials**

Fineness modulus not less than 1.0 shall be clean and free from organic and other deleterious materials

The fill materials shall be deposited and spread in successive uniform horizontal layers of about 150mm thick and compacted by use of mechanical 1.5 ton "Vibro" compactor or other approved devices to a 98% standard dry density in road and pavement sub-base and 95% standard dry density for other area. In filling /back filling against a newly constructed structure precaution must be taken so that the structure is well matured to take the thrust of filling and while filling that against a wall, the filling is done from both sides simultaneously.

Tests shall have to be carried out at recognized laboratory to ascertain the nature of the fill material and the degree of compaction obtained for the filled material for which samples have to be taken and transported to the recognized laboratory by the Contractor at his expense and as directed by the Project Manager.

## **5.6 Brick Flat Soling**

### **(BFS) Description**

The item shall consist of supplying and laying bricks on top of the earth or sand bed to form a sub-base.

### **Construction Requirements**

Bricks shall comply with requirements of First Class bricks. The binding sand shall have a minimum Fineness Modulus of 1.0 and shall be clean, and free of any organic matters.

Bricks shall be laid flat in surface to surface contact with adjoining bricks and their joints shall be filled with sand. The sand shall be brushed in until the joints are filled. Flushing in of sand with water shall not be done unless permitted. Bricks shall not be laid on the floor or foundation bed until the floor or foundation bed is inspected and approved by the Project Manager.

In case of Multi-layer Soling, care shall be taken to stagger or "break" all joints in placing subsequent courses of soling. No brick shall be laid on loose earth or earth filling which are not compacted to the desired degree.

## **5.7 Lean Cement Concrete (CC) Works**

The specification shall be the same as for RCC works excepting that:

- (i) No reinforcement shall be used;
- (ii) Proportion shall be as noted in Schedule of Items;
- (iii) 12 mm downgraded chips of Jhama bricks /Boulder shall be used as coarse aggregate as specified in Schedule of items;
- (iv) The curing shall be done for 7 days minimum;
- (v) Compaction of concrete may be done by wooden or steel tempers or rammers in lieu of vibrators.

In order to improve bond with masonry/concrete work coming above it, if required, the surface shall be roughened before it reaches initial set, by scouring with the help of a pointed tool.

## **5.8 Cement Concrete in**

### **Floor Description**

The work covered by this item shall consist of constructing in floor or elsewhere, 75mm or 38mm thick cement concrete with 1:3:6 mix of cement, sand of FM 1.2 and 12mm downgraded bricks or stone chips as specified in schedule of items.

### **Construction Requirements**

Construction shall be carried out as per requirements of drawing.

## 5.9 Damp Proof

### Course Description

The work covered by this item shall consist of constructing, on top of foundation walls or elsewhere 75mm/ 38 mm thick artificial stone with a 1:1.5:3 mix of cement, sand of FM 2.5 and 12 mm downgraded crushed stone chips and finishing with a coat of bitumen as per instruction of the Project Manager.

### Construction Requirements

Damp-proof course shall extend the full width of the plinth walls unless otherwise required by the plans and shall be laid only after the levels of the plinth have been checked.

## 5.10 Reinforced Cement Concrete Work

### (RCC) Description

This item shall consist of manufacturing concrete as provided in these Specifications and construction where required, and of the form, dimensions and design shown on the plans.

### Construction Requirements

Concrete shall consist of a mixture of Portland cement, fine and course aggregate and water. The proportions in which the various ingredients shall be used in the concrete mix for various work, shall be designed in accordance with the specified strength and suitable workability.

Material shall conform to the requirements specified below and in the relevant sections Material Specifications. Construction shall be according to these specifications. Contractor shall follow the following standards of American Society of Testing Materials along with the Building Code Requirements for Reinforced Concrete ACI 318-89 for Specification not covered in these Specifications. In case of differences between specifications contained in this book and those of ASTM or ACI, the specifications specified in this book shall stand.

## Cement

"Specification for Ordinary Portland Cement" (Type-I) "Specification for Concrete Aggregates"

"Standard Method of Making and curing concrete Test Specimen in the field"

"Standard Method of Test for compressive strength of cylindrical concrete Specimens"

"Standard Method of Sampling Fresh Concrete"

"Standard method of Making & Curing concrete Test Specimens in the laboratory"

"Standard method of obtaining and Testing Drilled Cores and Sawed beams of Concrete"

"Standard Specifications of Chemical admixtures in concrete"  
Cement shall be Portland Cement Type-I, ASTM

- ASTM C150 or BS12 - ASTM C 33
- ASTM C31-89
  
- ASTM C39-86
  
  
- ASTM C172-90
- ASTM C192-90
  
  
- ASTM C42-90
- ASTM C494
- ASTM C15



Portland cement to be normally used shall conform to ASTM specification C-150 type-I or BS-12. It shall be free from any hardened lumps and any foreign material other than the manufacturing ingredients. Cement shall have a minimum 90% of particles by weight passing the 75 micron sieve. Cement shall have an initial setting time in excess of 30 minutes and final setting time not longer than 7 hours. The Project Manager reserves the right to reject any cement that fails to achieve specified concrete strength as per proportion of materials laid down in the schedule of items.

Only approved brand, grade or kind of cement shall be used in a given structure above the ground level specially, for fare face finished concrete, tiles works etc. except upon the written permission of the Project Manager of other used.

The Contractor shall be responsible for the proper storage of the cement at the job site. Cement shall be stored in an air tight waterproof shaded area having damp proof floor, waterproof walls and leak proof roof. The cement stacks shall be placed at a minimum distance of 300 mm from the walls. The damp proof floor shall be constructed by raising it minimum 300 mm above the ground. If the cement is damaged and becomes lumpy due to defective storage, it shall be removed from the job site within 24 hours of receipt of instructions from the Project Manager.

Cement may be measured by weight of in a standard bag to weigh 1 cwt or 112 pounds/50kg having a volume of 0.0354 cum or 1.25 cft. The Contractor shall maintain the record of deliveries of cement to the site and its use in the work.

### **Fine Aggregate (Sand)**

Fine Aggregate shall consist of well-graded clean natural sand, free from injurious amount of organic impurities and deleterious substances and shall have a fineness modulus of not less than 2.50. Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves shall conform to the following requirements:

| <b>Sieve</b>       |   | <b>Mass Percent<br/>passing</b> |
|--------------------|---|---------------------------------|
| 9.5 mm (3/8 in)    | : | 100                             |
| 4.75 mm (No.4)     | : | 95 - 100                        |
| 1.18 mm (No. 16)   | : | 45- 80                          |
| 0.300 mm (No. 50)  | : | 10 – 30                         |
| 0.150 mm (No. 100) | : | 2 -10                           |

## Coarse Aggregate

Coarse Aggregate shall consist of well-graded broken or crushed first class jhama bricks or boulder chips as specified on the structural drawings and/or BQ and shall be free from any adherent coatings.

### Grading of Coarse Aggregates

Coarse aggregate shall be well graded, between the limits specified and the size or sizes designated shall conform to the requirements given in the following tables or otherwise specified or directed by the Project Manager.

| Designated sizes  | Percentage by weight passing US Standardsieves having square openings |        |        |        |       |      |      |
|-------------------|-----------------------------------------------------------------------|--------|--------|--------|-------|------|------|
|                   | 38 mm                                                                 | 25 mm  | 20 mm  | 12 mm  | 10 mm | No.4 | No.8 |
| 25 mm down graded | 100                                                                   | 95-100 | --     | 25-60  | --    | 0-10 | 0-5  |
| 20 mm down graded | ----                                                                  | 100    | 90-100 | --     | 20-55 | 0-10 | 0-5  |
| 12 mm down graded |                                                                       | --     | 100    | 90-100 | 40-70 | 0-15 | 0-5  |

### Delivery and Storage of Materials:

#### a. Cement

In transit and storage or stock-piled at site shall be protected from dampness or any damage by climatic conditions that would change its characteristics or usability. Cement at site shall be stored in dry weather proof godowns (or shed) built at the cost of the Contractor. Cement must not be stacked in more than 10 bag height. Sufficient space shall be provided for circulation and rotation of bags in order to minimize the length of storage of any of the bags. The floor of the godown shall consists of wooden planks resting on base prepared of dry bricks laid on edge. Batches of cement shall be used for the work in the order in which they are delivered to the site. A register shall be maintained by the Contractor listing date of delivery and quantity of each consignment for easy identification.

#### b. Aggregates

Aggregate shall be stock-piled at least 7 days prior to their anticipated use to permit the Project Manager to sample each stockpile to determine the acceptability of the material for the intended use.

Aggregates of different sizes or grades and from different sources of supply shall not be mixed. All aggregate shall be stored free from contact with earth and other deleterious matter.

Every precaution shall be taken during transport and stockpiling of coarse aggregate to prevent segregation.

Segregated aggregates shall not be used until they have been thoroughly remixed and the resultant pile is of uniform and acceptable grading at any point from which a representative sample is taken.

### Composition of Mix

The strength requirement and workability shall govern the mix proportion for each class of concrete:

| Proportion of concrete | 28 day cylinder crushing strength (min.) | Place of Use                                                                                                 | Aggregates        |                              | Min. Cements per m <sup>3</sup> (50 kg bag) |
|------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------|------------------------------|---------------------------------------------|
|                        |                                          |                                                                                                              | Fine              | Coarse                       |                                             |
| (1:1.5:3)              | 21 MPa                                   | In footing, water tank, column, slab, beam, stair lintel and all other RCC works like switch yard foundation | Sand FM 2.5       | 20 mm down graded stone chip | 8.0 bags                                    |
| (1:1.5:3.0)            | 20 MPa                                   | In Damp Proof Coarse                                                                                         | Sand FM 1.2       | 12 mm down graded            | 8.0 bags                                    |
| (1:2:4)                | 18 MPa                                   | In all RCC works in Ancillary Structures                                                                     | Sand FM 2.5 & 1.5 | 20 mm down graded            | 6 bags                                      |
| (1:3:6)                | 15 MPa                                   | In bellow foundation and Floor(C.C )                                                                         | Sand FM 1.5       | 20 or 12 mm downgr           | 4.5 bags                                    |

**Slump** Slab, Beam, Columns etc. -50mm.

Trial mixes for every class of concrete with representative materials from site shall be prepared by the Contractor and carried to the laboratory in accordance with approved procedure. The nominal strength in these tests shall exceed the specified minimum strength by at least 20%. No concrete shall be placed in the permanent works until the relevant mix has been approved by the Project Manager.

### Batching

The Contractor shall provide and maintain in good order suitable measuring equipment and devices required to determine and control accurately the relative amounts of various materials entering the mix. All measurements shall be by weight/volume and shall be accurate within a tolerance of 1 % for each batch. If the measurements are by volume then standard wooden boxes shall be used.

**a. Cement**

Unless an integral number of bags, as packed by the manufacturer is used, the Cement shall be weighed. A bag of cement weighing 50 kg net shall be considered as 0.035 m<sup>3</sup>

**b. Aggregates**

Different types and sizes of aggregates shall be batched separately by weight/volume.

**c. Water**

The amount of mixing water shall be weighed/measured, allowance being made for the quantity of the free water contained in the aggregates. Water cement ratio shall be decided for every class of concrete and according to the place of use. The water/Cement ratio shall not exceed 45% by weight for all type of concrete.

Sufficient acceptable materials shall be available at the batching site to ensure continuous placement necessary for structures. The moisture content of the accepted aggregate shall remain consistent to the extent that the resultant successive batches of concrete do not vary in consistency by more than 6 mm of slump. If the moisture content in the aggregate varies by more than the above tolerance, corrective measures shall be taken to bring the moisture to a constant and uniform quantity before any more concrete is placed.

Coarse aggregate shall be saturated with water at least 12 hours before use to prevent absorption of the mixing water.

**MIXING OF CONCRETE****a) Machine Mixing:**

Concrete shall be mixed in concrete mixer of approved type and appropriate capacity.

Each batch shall be thoroughly mixed for a period of not less than 2 minute after all materials including the water are in the drum and during this period the drum shall be in the mixing position and revolve at uniform rate of not less than 14 or more than 20 revolutions per minute. The cement and sand shall be thoroughly mixed in dry condition.

The batch shall be so charged into the mixer drum that some water shall enter in advance of the cement and aggregate. The entire content shall be removed from the drum before the succeeding batch is placed.

Concrete shall be mixed in quantities required for immediate use. Concrete shall not be used which has developed initial set or which is not in place within thirty (30) minutes after the water has been added. Re-tempering of partially hardened concrete by remixing with or without additional materials or water, or by other means shall not be permitted. The inside of the mixing drum shall be kept free of hardened concrete at all times.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the Project Manager, the first batch of concrete through the mixer shall contain only two thirds of the normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

**b) Hand Mixing:**

Hand mixing shall not be permitted except for unimportant structural members and only at the discretion of the Project Manager. When hand mixing is permitted it shall be taken to ensure that the mixing is continued until the mass is uniform in colour and consistency. If hand mixing is permitted by the Project Manager, the Contractor shall use 10% extra cement for hand mixing for which no extra payment will be made.

**Consistency of Concrete**

The consistency of concrete shall be determined following evaluation of the placement conditions for each individual section of the work but in no case the slump shall exceed 62mm unless otherwise decided. Mix proportions and consistency shall produce a dense, well compacted concrete with a minimum tendency to segregate under placing conditions, free from sand streaks, honeycomb, air-pockets, exposed reinforcing steel and other forms of structural weakness or unsatisfactory appearance.

**Transport and Placing**

Concrete shall be so transported from the mixer and placed in the form that contamination, segregation or loss of the constituent materials does not occur. Before placing the concrete, all form work, space and the reinforcement contained in it shall be thoroughly cleaned of all extraneous matter. Care shall be taken to fill every part of the forms, to work the coarse aggregate back from the face so that sufficient mortar shall be flushed from the mass to form a smooth surface, and to force the concrete under and around reinforcing bars without displacing them.

The concrete shall be deposited in the forms in horizontal layers to a depth not exceeding 300 mm and each layer shall be properly vibrated before laying the next one.

The concrete shall not be dropped freely from a height exceeding 1.0 meter nor shall it be deposited in large quantities at any point. In columns of structures special tremie pipe may be used for drop more than 1.8 meters. Dragging of concrete inside the forms or distribution by vibrators or allowing it to flow by gravity to the ends of the forms shall not be permitted.

In sections where it is extremely difficult, to place concrete containing the larger sizes of the coarse aggregate, a modified mix, as approved by the Project Manager, may be used to ensure against honeycomb and separation of the coarse aggregate from the mortar. Concrete shall be deposited and compacted in its final position within 30 minutes of its discharge from the mixer and shall not be subjected to vibration between 2 and 24 hours after compaction. When in situ concrete has been in place for 4 hours no further concrete shall be placed against it for a further 20 hours.

## Compaction

Concrete, during and immediately after placing, shall be thoroughly compacted by mechanical vibration. The vibration shall be internal unless otherwise authorized by the Project Manager.

Vibration shall be of a type and design approved by the Project Manager. It shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.

The intensity of vibration shall be such as to visibly affect a mass of concrete of one inch slump over a radius of at least 450 mm.

The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms. He also provided sufficient number of nozzles of different diameter to execute the work smoothly.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to lie plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation. Vibrators shall not be used to transport concrete in the forms.

Concrete pouring schedules and construction joint sequences of different stages shall have to be approved well in advance by the Project Manager.

## Construction and Expansion Joints

Expansion joints shall be constructed at the locations and to the dimensions shown on the plans. Position and detail of construction joints, not shown on the plans, shall be planned in advance and approved by the Project Manager. Placement of concrete shall be in a continuous operation between consecutive joints.

Where sections of the work are carried out in lifts, the line of the proposed joint on all exposed surfaces shall be made truly straight by tacking a temporary horizontal straight edge on the inside of the form with its lower edge on the line of the joint and then placing concrete 12 mm higher than this edge to allow for settlement. In case of water reservoir PVC water stopper shall be used in all construction joints with 250 mm overlapping at the water stopper joints.

In resuming the work, the old concrete surface shall be thoroughly cleaned of laitance and all loose material by stiff wire brush, roughened, if deemed necessary, and washed with clean water.

The surface then shall be coated with very thick cement slurry before fresh concrete is placed.

## **Water Reservoir/Tank**

Admixture of Sika Plastocrete Super (Conforms to both IS 2645 and IS 9103) 0.2% by weight of cement or similar product of approved quality at manufacturer recommendation for heavy duty water tank are to be used in bases and walls of R.C.C. reservoirs/tank.

## **Special Casting process for Columns and R.C.C. Wall**

Minimum of construction joints shall be allowed in beams, slab and column of the structures. No construction joint in columns from below floor to bottom of beam shall be allowed, column must be cast in a lift, to avoid any construction joint below lintel level. Special shuttering with opening at middle height shall be used for the facility of casting. The opening shall be closed after casting of concrete up to that level without disturbing the green concrete. The Contractor shall prepare shuttering details ahead of actual work and shop drawings are to be approved by the Project Manager. In any case the safety and stability of form work shall be the Contractor's responsibility. No construction joint shall be allowed between beam, web & roof slab of building. For wall & water reservoir no concrete shall be placed from a height of more than 1.0m and the shuttering of the wall shall not be more than 1.25m in height.

## **Control Tests for Concrete**

### **a. Sampling:**

The number, frequency and location of batches to be sampled shall be decided by the Project Manager. The method of sampling shall be according to ASTM C172.

### **b. Slump**

This determination shall be made at the commencement of concreting, on the occasion of each change in mix proportions, and thereafter when requested by the Project Manager. The testing shall be in accordance with ASTM C- 143, current issue.

### **c. Compressive Strength**

Test cylinders 150 mm in diameter and 300 mm high shall be made at the site of the work in sets of three (3) from each thirty (30) cubic meter of each class of concrete or fraction thereof or as directed by the Project Manager.

Casting and curing the concrete cylinders shall be in accordance with ASTM C-31, current issue. Testing of cylinders shall be done in accordance with ASTM C- 39, current issue; one cylinder at 7 days and 2 at 28-days. Cylinder at 7 days test shall not be less than 70% of the specified (design) strength.

If the Project Manager allows cubes to be tested instead of cylinders, the cube strength shall be at least 25.0 percent higher than the cylinder strength specified.

The Contractor shall arrange to transport the cylinders/cubes to the approved laboratory and arrange to have the test results forwarded (in duplicate) directly from the laboratory to the Project Manager or his appropriate site representative. The Contractor shall bear all expenses in connection with the preparation of test cylinders /cubes, i.e. provision of moulds, cost of concrete, labor and transportation charges to the approved laboratory, laboratory testing charges etc.

## Formwork

Formwork may consist of steel sheets of minimum thickness of 14 BG or wooden planks of hard wood of approved variety having a minimum thickness of 45 mm with necessary battens, struts, stringers, beams, ties, etc. In case of wooden planks the same shall be new and shall not be used more than three times in contact with concrete.

All formworks, especially for fair face concreting, must be 12 BG steel sheet and should be dented, rust free by using of sanding disk etc. before every lift of casting.

All formwork shall be of sound materials constructed water-tight, true to line as per drawing and of such rigidity to prevent bulging or movement during the placement and curing of the concrete. Form work for bases and walls of water reservoir shall have chamfer of appropriate dimension as per drawing and direction. After hardening the concrete shall conform to the shape, dimensions and surface finish described in the Contract. The forms shall be simple in construction, easy for erection, maintenance and removal

Form lining shall be in largest practicable panel to minimize joints. Under usual conditions the following minimum periods between concreting and the removal of formwork shall be observed:

|                                            |                                                    |
|--------------------------------------------|----------------------------------------------------|
| Vertical sides                             | : 72 hours                                         |
| Soffits from under span of 6 meter or less | : 18 days                                          |
| Soffits from under span of over 6 meters   | : Min. 21 days and as directed by Project Manager. |



Concrete exposed by the removal of formwork shall be left untouched pending inspection by the Project Manager. Cement mortar separators or block of appropriate sizes are to be used in all covering as per drawing or directed by Project Manager.

The drip course shall be constructed at the edge of roof slab etc. by means of an approved batten included in the form work before casting or after casting as desired by the Project Manager.

### **Surface Finish and Remedial Treatment of Surfaces**

Unless otherwise provided on the plans, all reasonably true and even surfaces, which are of uniform colour and texture, and free from stone pockets, honeycomb, depressions or projections, shall be considered as acceptable surfaces.

Immediately after the removal of forms, all cavities produced by form ties and all other holes, broken corners or edges and other defects except air bubble holes, shall be cleaned and after having been kept saturated with water for a period of not less than two hours shall be completely filled, rammed and made good with a mortar of the same proportions as used in the concrete being finished.

The holes shall be completely filled by use of a pressure gun or hand rammed method as directed by Project Manager's representative.

Any remedial treatment to surfaces shall be agreed with the Project Manager following inspection immediately after removing the formwork and shall be carried out without delay. Any concrete, the surface of which has been treated before being inspected by the Project Manager, shall be liable to rejection.

### **Curing and Protection**

Concrete shall be protected against harmful effects of weather for a period of not less than seven (7) days immediately following the placing of concrete.

All concrete surface shall be covered with two thicknesses of wet burlap which have been spot stitched, or wet jute felt or gunny bags as soon after placing of concrete as it can be done without marking the surface and kept thoroughly wet by continuous sprinkling of water for a period of not less than 21 days after the concrete has taken its final set.

In lieu of continuous sprinkling, plastic sheeting or plastic coated burlap may be used to prevent moisture loss. The concrete RCC shall be pre-moistened and the plastic sheeting shall be held securely in place so that positive moisture seal is provided to retain the curing moisture during the 21 days curing period. Form of perforated sheeting shall be without delay repaired or replaced with acceptable material.

## **TRAINED SUPERVISOR**

It is essential that the Contractor's supervisor who is in charge of the construction of all concrete work whether reinforced or not, shall be skilled in this class of work and shall superintend personally the whole construction and pay special attention to :

- a) The quality, testing, proportioning and mixing of the materials and particularly control of water cement ratio
- b) Laying of materials in place and thorough consolidation of the concrete to ensure solidity and freedom from voids.
- c) Position of reinforcements.

### **5.11 RCC with Water Proofing**

#### **Admixture Description**

This item shall be done as described in item 2.12 except that for water proofing admixture of Sika Plastocrete Supper (IS: 2645, and IS 9103) in proportion of 0.2% by weight of cement' or "SUPER BARBARA 05" of MBI International AG, NITTOPROOF of FOSROK or equivalent, made in UK/Switzerland/Singapore/Saudi Arabia/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer) in proportion recommended by the manufacturer is to be used in the concrete of the basement mat & wall, underground water reservoir and where necessary.

#### **Construction Requirement**

This approved admixture shall be put to the concrete mixture machine along with the cement. Other procedures are same as in item 2.10 including formwork etc.

### **5.12 Reinforcing Steel in**

#### **Concrete Description**

This item shall consist of furnishing and placing in concrete reinforcing steel (Deformed bar) of quality type size and quantity designated, all as required by these Specifications and as shown on the applicable structural drawings.

#### **Construction Requirements**

Reinforcing steel shall be deformed bars of 60 graded as specified on the structural drawings and shall meet the following requirements:

1. Quality of reinforcement steel, its properties including strength, elongation, bending, splicing, hooking, covering and all related events shall be in accordance with the requirements of ACI 318-89.

2. De-formed bars, when used shall meet the requirements of BS: 4461 or ASTM: A615 of high strength of 60 - grade.

It should be noted that steel made from scrap iron shall not be accepted for any type of work. All reinforcement bars shall be clean and free from loose scale, dirt, paint oil, grease or other foreign substance. Bars should be placed in position as drawing/design requirement and be cleaned with a stiff wire brash if required.

## Bending of Reinforcement

All reinforcement bars shall be bent cold to pertinent dimensions using bending appliances and method approved by the Project Manager. All bars of slab and beam shall invariably have standard hooks at the end. All standard hooks shall meet the following requirements:

- a. A semicircular turn plus an extension of at least four bar diameters but not less than 62 mm at the free end of the bar.
- b. A 90 degree turn plus an extension of at least 12 bar diameters at the free end of the bar.
- c. For stirrup and tie anchorage only either a 90 degree or a 135 degree turn plus an extension of at least six bar diameters but not less than 62 mm at the free end of the bar.

The radii of bend measured on the inside of the bar for standard hooks shall not be less than the values given below:

| Bar Size            | Minimum Radii |
|---------------------|---------------|
| 10 mm, 12 mm, 16 mm | 2.5 bar dia.  |
| 20 mm, 22 mm, 25 mm | 3 bar dia.    |

Bends for stirrups and ties shall have radii on the inside of the bar not less than one bar diameter.

## Placing of Reinforcement

Reinforcement shall be placed, supported and maintained in the position shown in the Drawing and shall be checked and approved by the Project Manager before placement of concrete begins. Unless otherwise permitted by the Project Manager, all intersecting bars shall be tied together with double layer of 22G black iron wire and the ends of wire shall be turned into the main body of the concrete. Clear cover must be maintained to the side of reinforcement as shown on the drawing by using concrete blocks or separators.

## Splicing of Reinforcement

No splices shall be made in the reinforcement where not shown in the drawing. Wherever it is necessary to splice reinforcement at points other than those shown on the plans, Drawings showing the location of each splice shall be submitted to and approved by the Project Manager before the reinforcing steel is placed.

a. **Splices in reinforcement in which critical design stress is tensile**

Splices at points of maximum tensile stress shall be avoided where possible, such splices where used shall be lapped or otherwise fully developed. In any case the splice shall transfer the entire computed stress from bar to bar without exceeding three fourths of the permissible bond values for the concrete. The length of lap shall be 40 bar diameter excluding hook. However length of splices to be used for different bars shall be according to drawing or according to the direction of Project Manager.

b. **Splices in reinforcement in which critical design stress is compressive**

Where lapped splices are used it shall be minimum of 35 bar diameters excluding hook. Where longitudinal bars are offset at a splice the slope of the inclined portion of the bar with the axis of the column shall not exceed 1 in 6 and the portions of the bar above and below the offset shall be parallel to the axis of the column. Adequate horizontal support at the offset shall be secured by additional stirrups, ties, etc. Offset bars shall be bent before they are placed in the forms.

## **Supports**

Precast concrete blocks or metal supports of adequate strength, of proper dimension and in sufficient number shall be used for supporting the bars in position. Blocks shall be of a shape acceptable to the Project Manager and designed so that they shall not overturn when concrete is stored. They shall be made of concrete with 10 mm maximum aggregate size from same materials and of the same mix proportions as that of the concrete in which they are to be used. They shall be cast and properly cured for at least seven days before use and shall have wire or other device cast in the block for the purpose of attaching them securely to the reinforcement. Where directed chairs made with 12mm bars shall be provided for keeping the negative reinforcement in place during concreting. These chairs when used shall provide proper cover as required and the numbers shall be as decided by the Project Manager.

## **Welding of Reinforcement**

Reinforcement in structures shall not be welded except where permitted. All welding procedures shall be subject to the prior approval of the Project Managers in writing. In pile reinforcement welding may be necessary and shall be done in accordance to the drawing and with the approval of the Project Manager. Welding for connecting the damaged portion of the reinforcement shall be allowed on both sides of the Re-bar and shall be 50 mm of welding length on both sides and on ends.

If welded connections are made on intermediate grade reinforcing steel, to hold bars in position, low hydrogen electrodes shall be used.

## Concrete protection for Reinforcement

Unless otherwise shown on the plans, the covering of reinforcement for different types of members shall be as follows:

|                                                                   |  |                |
|-------------------------------------------------------------------|--|----------------|
| <b>Column, Footing/Mat &amp; Pile Cap</b><br>All sides, below FGL |  | 75 mm          |
| <b>Column:</b><br>All sides, above FGL                            |  | 50 mm          |
| <b>Grade Beam:</b><br>All faces                                   |  | 60 mm          |
| <b>Other beams in Structures:</b><br>Side, Top and Bottom         |  | 50 mm          |
| <b>Slab, lintle and staircase:</b><br>Botto<br>m Top              |  | 25 mm<br>20 mm |

### Protective Coating

All exposed reinforcing steel at construction joints shall be protected with a brush coat of neat cement, mixed to a consistency of thick paint, within one week after the placing of the initial concrete, unless it is definitely known that the steel shall be embedded within 60 days. This coating shall be entirely removed, by lightly tapping with a hammer or other tool, more than one week previous to the placing of the final pour. The Contractor shall notify the Project Manager or his authorized representative when the steel has been placed in position for pouring concrete and no concrete shall be placed until the Project Manager has inspected the steel and given his approval in writing.

### 5.13 Brick Work

#### 5.13.1 250mm BRICK WORK AND ABOVE

#### Description

This item shall consist of constructing brick masonry work in **1:5** cement mortar in such thickness and at such heights as required by the plans.

#### Construction Requirement

All materials shall meet the requirement of the relevant sections of Material Specifications.

- Bricks** shall be 1st class well burnt bricks of uniform colour, shape, size with sharp corners bricks unless otherwise specified.
- Cement** shall be Portland cement Type-I ASTM C- 150 or BS - 12
- Sand** shall be clean well graded natural sand having a minimum FM of 1.5.
- Water** shall be same as required for concrete.

## **Mortar**

Mortar of brickwork unless otherwise required shall consists of 1 part of cement and 5 parts of sand.

Cement and sand shall be mixed dry in the specified proportions until the colour of the mixture is uniform. Water shall then be added sparingly, only the minimum necessary being used to produce a workable mixture of normal consistency, The water cement ratio in no case shall exceed 0.50 by weight, or as directed by the Project Manager.

The mixing shall be done on a clean hard platform with watertight joints to avoid leakage. The mixture should be covered with polythene sheet or other means so that dust or other foreign materials cannot be deposited. At the close of each day's work, the mixing trough and the pans shall be thoroughly cleaned and washed.

Mortar shall be mixed in quantities required for immediate use within 30 minutes of mixing.

Mortar, which has taken its initial set, shall, on no account be used on the work, nor shall it be remixed with or without additional materials or re tempered by other means.

## **Workmanship**

No bricks shall be used until they have been thoroughly soaked in clear water for at least eight hours. Soaking shall be discontinued one hour before use. Care shall be taken that the bricks are clean and free from lime or dirt of any kind. If necessary, bricks shall be scrubbed clean.

Brickwork shall be built in plumb and shall be carried up regularly throughout the entire length of the structure. Unless otherwise specified, bricks shall be laid in English Bond unless otherwise specified each brick being set with mortar in bed and vertical joints. All bricks shall be whole except where necessary for closers and where expressly authorized. All horizontal joints shall be parallel and level. Vertical joints in alternate courses shall come directly over one another. Joint thickness should be uniform and shall be 6 mm for pointing brick work and shall in no case exceed 10 mm for other brick works. Exposed joints shall be raked and flush-pointed unless otherwise specified and the face of the work shall be kept clean as work proceeds. The height of day's work shall be limited to 1.25 meter unless otherwise permitted. In exposed situations the day's work shall be protected against harmful effect of weather during and for a period immediately following construction until the mortar has sufficiently hardened. All brickwork shall be thoroughly cured for a period of at least 7 days. Fixture in masonry such as anchors, clamps, brackets, pipes, etc. shall be built-in during construction at no additional cost to the Contract.

### 5.13.2 125 mm THICK BRICK WORK

The work covered by this item shall consists in constructing 125 mm thick wall with 1st class bricks in 1:4 cement mortar at any heights as required by the plans.

#### Construction Requirement and Materials

Materials and method of construction shall be as stated in item 2.13.1 except that the mortar shall consist of 1 part of cement and 4 parts of sand.

### 5.14 Patent Stone

#### Flooring Description

The item shall consist of constructing 25 mm /38mm thick concrete with 12 mm downgraded picked "Jhama" brick chips, sand and cement in specified panels of floor slab and elsewhere in accordance with these Specifications, Use approximately 25 kg of cement per 10 m<sup>2</sup> for neat cement finish and finish with steel trowel up to the satisfaction of Project Manager or as directed.

#### Construction Requirements

Materials and construction shall be in accordance with the requirements of item 2.10. The flooring shall be laid preferably not later than 24 hours after the floor slab is poured. When flooring is to be laid on an older concrete slab, the base surface shall be thoroughly cleaned of all loose materials by stiff wire brush, roughened if seemed necessary and washed and soaked with clean water. Surplus water shall be removed and a dense cement grouting is applied to the surface before flooring is placed.

The floor shall be divided into panels of specified sizes, which shall not be more than 16 sq. m. by means of wooden 'battens. The top of the battens shall be at the level of the finished "surface.

The mixture shall be spread evenly between the battens in alternate panels and shall be uniformly consolidated and leveled by a strike-off. When the moisture has disappeared from the surface, the surface shall be steel trowelled under firm pressure to produce a dense uniform smooth surface free from trowel marks.

The dividing battens shall be removed carefully after 16 hrs and the remaining panels shall be completed in the aforesaid manner. Joints would be marked with thin ropes to allow cracks, if any, to form along straight line and providing neat appearance.

The work shall be cured and protected from weather for at least 10 days immediately following the laying.

## **5.15 Ceramic Tiles**

### **5.15.1 Glazed Ceramic**

#### **Tiles Description**

The work covered under this item shall consist of supplying and fixing glazed ceramic tiles on walls and where necessary on a 1:3 cement mortar in accordance with the applicable plans, schedules and these specifications.

#### **Construction Requirements**

Glazed ceramic tiles unless otherwise specified, shall be standard Grade 200mm x 300mm x 6mm and 250mm x 400mm x 6mm white interior wall tiles free from war page, blemishes and dimensional defects and conforming to the standards of Federal specification SS-T-308b.

Mortar for installation shall consist of 1 part cement to 3 parts sand (FM 1.5).

Grout for tile joints shall be made of white cement coloured as and where specified with inert pigments.

Preparation of wall surface and application of mortar bed shall comply with the provisions of item 2.16.1 & 2.16.2. If the surface needs leveling a scratch coat of plaster shall be applied, leveled and scratched for key and allowed to dry for 12 hours before installing tiles. The setting mortar shall be applied evenly and a neat-cement paste to a thickness of about 1.5mm shall be trowled to the back of tile and the tile set on firmly tapped into place to ensure full contact. The joints shall be in specified pattern and shall not exceed 1.5 mm in width.

The mortar bed shall be minimum 6mm thick and shall be cut through horizontally and vertically every 400 mm to 600 mm. The tiles shall be soaked in water for at least 6 hours before setting. Installation shall be controlled by strings, pegs, spacers, levels or other suitable methods to ensure correct layout and uniform leveled joints. The joints shall be grouted, cleaned and damp-cured for at least 3 days.

### **5.15.2 Non Slip Tiles Work**

The Non slip tile shall be smooth, water proof, dust pressed with square edges and size of the tiles shall be between 200mm x 300mm or 250mm x 250mm or 300 mm x 300 mm. No border edging or rounding pieces shall be used. Length of each size of floor/wall shall be filled by the tiles completely. The cut sizes if used at the ends shall be equal in size and as closed to full size as possible by making either the edge or the centre of tile to coincide with the vertical centre line of floor/wall. The wall/floor on which the tile shall be applied shall be kept moistened for 2 hours. The bedding mortar in 1:2 using medium sand (FM 1.5) shall be applied. The joints in tiles shall be minimum 5 mm wide, kept clean for pointing and to be filled flush with pointing material with white or coloured cement mortar unless otherwise specified. Measurement shall be given for the actual area covered by the tiles. No measurement of the under bed shall be given.



## 5.16 Plaster Work

### 5.16.1 Plaster on Brick

#### Masonry Description

This item shall consist of providing 12 mm to 20 mm thick (1:4)/ (1:6) on walls, and where necessary in accordance with these Specifications & direction of Project Manager.

#### Construction Requirements

Materials shall meet requirements specified below and in the relevant section of Material Specifications.

- a. **Cement** shall be Ordinary Portland cement Type-I ASTM C- 150 or BS-12
- b. **Sand** shall be clean well-graded natural sand having a fineness modulus of 1.50. Sand shall be washed if necessary.
- c. **Water** shall be potable and clean and contain no salt or organic materials.
- d. **Admixture** shall be mixed with the cement mortar of approved quantity where item in BOQ is specifically mentioned.

Cement and sand shall be mixed dry in the specified proportion until the mixture is uniform in colour. Only enough water shall be added to provide plasticity. Mortar shall be mixed only in quantities for immediate use. Mortar which has taken initial set shall not be used on the work with or without addition of fresh material.

Before application of plaster, the joints in brick walls shall be adequately raked out where necessary and smooth concrete surfaces shall be roughened to provide key. The surfaces shall be scrubbed clean of loose materials and soaked with water and kept damped for 24 hours in case of brick masonry.

Plaster which consists of two coats, under and finish, when applied over brick masonry, the "under and finish coats shall be applied with an interval to permit the undercoat to set. Water proofing admixture of specified quantity shall be mixed with cement mortar as per manufacturer's instruction.

Plaster shall be kept moist by watering and protected from weather for at least 10 days immediately following completion.

If any cracks appear in the plaster or any part sounds hollow when tapped or is found to be soft or otherwise defective after the plaster has dried, it shall be considered as defect and the defect shall be made good by cutting out and re-plastering at the Contractor's own cost.

### 5.16.2 Plaster on R.C.C

#### Surfaces Description

This item shall consist of providing 6 mm to 12 mm thick 1: 4 cement-sand plasters on all RCC members in accordance with this Specification.

#### Construction Requirement

Plaster shall consist of 1 part cement and 4 parts sand and have thickness of 6 mm and shall be applied in a single coat, where plaster on concrete surface is required 12 mm thick, it shall consist of two coats, under and finish. The under coat shall consist of a grout application and shall have minimum thickness of 6 mm and shall be leveled with straight edge and scratched for key. The finish coat shall be trowelled over with care and leveled with straight edge to obtain a flat smooth surface. The under and finish coats shall be applied with an interval to permit the under coat to set. All edges and corners unless otherwise shown on the plans, shall be rounded or chamfered as directed by the Project Manager. All moldings shall be neat, clean and true to template.

### 5.16.3 Plaster with Water Proofing

#### Admixtures Description

This item consists of providing 20 mm thick 1:4 cement mortar plaster with water proofing admixture of "Sika Plastorate Super" 0.2% by weight of cement or any other admixture of internationally reputed manufacturer in the proportion recommended by them shall be used as per manufacturer's instruction. This plaster shall be used on RCC surface or Brick wall or as directed by Project Manager.

Construction Requirement: Plaster shall consist of 1 part of Portland cement and 4 parts of sand with recommended quantity of approved water proofing admixture. However the whole procedure of this works shall be subject to the approval of the Project Manager.

### 5.17 Neat-Cement

#### (Skirting/Dado) Description

This item shall consist of providing 12mm thick neat cement with black/red oxide finished **(1:2)** cement-sand Skirting/Dado on a **(1:4)** cement-sand mortar plaster of 12 mm thick underbid on walls or where necessary in accordance with these specifications.

#### Construction Requirements

Materials shall meet requirement as stated in item in 2.16.1

Wall plaster, if any, shall be removed along the floor to the required height and the surface shall be thoroughly scrubbed and wetted before applying the underbid. The second undercoat shall have a nominal thickness of 6 mm and the total built-up thickness shall be same as that of the plaster on

the wall. A 3 mm deep and 3 mm wide groove shall be formed where skirting/Dado meets wall plaster.

The skirting/Dado shall be installed flush with the finished wall surface. The intersection with the floor shall be a right angle and the top of the skirting/Dado shall be straight and sharp.

The underbid shall be laid as uniformly as possible and allowed to become firm before scratching for key and subsequently allowed to become thoroughly dry before applying the second undercoat. A neat cement paste 3 mm thick shall be spread evenly over the second coat and shall be steel trowelled under firm pressure to produce a dense uniform smooth surface free from trowel marks.

The work shall be cured and protected from weather for at least 10 days immediately following the installation.

## **5.18 Making Groove on Wall**

### **Surface Description**

The work covered by this item shall consists of making groove of 38 mm wide & 25 mm deep and to be provided on all types of wall surface as per drawing and direction of the Project Manager. The *faces* of the groove must be straight and well finished.

### **Construction Requirement**

Before making groove wall shall be chiseled to attain the required depth of the groove. Care shall be taken for chiseling. In case of any damage the Contractor shall make good to the damage at his own cost.

#### **5.18.1 Making Groove in RCC Casting (On Railings, Drop Walls & RCC**

### **Walls) Description**

Fair faced concrete of drop wall, railing and RCC wall shall have 20mm deep grooves as shown. All horizontal grooves shall be 40mm wide in the front and 30mm wide at the back and all vertical grooves shall be 25mm wide in the front and 20mm wide at the back.

Continuous horizontal grooves shall run between the parapet and the slab and also between the slab and the drop wall. Vertical grooves shall be 2.20m apart, positioned along the column axes and additionally two numbers in each bay except when otherwise shown. For R.C.C works in lift walls and staircase walls, the grooves shall be positioned as shown in the drawing. This is to be done by using approved hard wood plank made plain as per sizes to be fixed on the shuttering before casting of fair faced concrete. This wedge shaped timber shall be used for one time only and shall have to be changed/ replaced at the time of changing of plywood during shuttering work of fair faced concrete. This timber must be straight and free from any defect. REEBOL release agent or any other approved type is to be used before every casting.

## **5.19 Painting Works**

### **5.19.1 Distemperin**

#### **g Description**

The item shall consist of applying 2 coat of distemper of approved color over a coat at priming on plastered wall or ceiling surfaces where necessary in accordance with this specification.

#### **Construction Requirements**

Distemper shall be water bound distemper of Bangladeshi made (SPD of BERZER) of approved colour, shade and supplied in original sealed container. Priming consist of chalk wash with glue. The surface to be distempered shall be dry, well cleaned and free from efflorescence, dirt and stain of grease. The surface shall be given a thorough rub down to remove all loose materials and all cracks and surface irregularities shall be repaired with patching plaster and filler to obtain a smooth and even surface. The mixing of distemper shall be carried out in accordance with the instruction issued by the manufacturer of the particular brand of distemper that is to be used. Before starting work distemper shall be mixed in such way that one room can be finished with the same mix. Distemper is to be applied quickly. The brush to be dipped and stroked cross wise on the surface. No patchy overlaps shall be tolerated under any circumstances. Distemper shall only be applied with proper distemper brushes as supplied or recommended by the manufacturer. A sample area must be prepared first and got inspected and approved by the Project Manager before the full scale work commences. The distempers shall be used till such time as it gives a uniform texture.

### **5.19.2 White**

#### **Wash Description**

The work covered by this item shall consist of applying minimum 3 coats of white wash with lime on plastered or un-plastered surfaces in accordance with these Specifications.

#### **Constructional Requirements**

Lime shall be slaked lime. The wash shall be prepared by mixing and stirring lime and water in such quantities as shall produce a mixture of the consistency of thin cream. When sufficiently mixed, the mixture shall be strained through a clean coarse cloth. Gum Arabic in proportion of 1 lb of gum to 15 lb. of lime shall be dissolved along with approved quantity of blue & zinc oxide in the strained wash.

The surface to be white washed shall be thoroughly cleaned of all foreign matter by the use of stiff wire brush, sand papering or other approved means. White wash shall be applied in minimum 3 coats alternately laid on vertically and horizontally. Each coat shall be perfectly dry before the succeeding one is laid over it. The wash shall be laid on with good hair brush & not with brush made of jute. The wash shall be laid in such a way that the whole surface should give a uniform texture.

### **5.19.3 Water Repellent Coating**

## Description

The item shall consist of applying 2 coats of clear silicone water repellent on exposed brick or concrete surfaces and cement plaster on wall, ceiling and elsewhere in accordance with these Specifications.

## Materials

Silicone water repellent shall consist of sodium silicate or other alkaline silicates based clear approved product supplied in original sealed containers bearing the manufacturer's trademark.

## Application Method

The application of water repellent coat shall strictly comply with the manufacturer's instructions. The application shall preferably be carried out after a period of dry weather and before applications; the surface shall be thoroughly clean and dry. A heavy coat shall be applied evenly direct from the container by flooding the surface with a wide brush so that at least 6mm penetration is achieved.

A second coat, applied as above, shall follow after 24 hours subjected dry & clean weather.

### 5.19.4 Enamel

## Paint Description

The work covered under this item shall consist of applying 2 (two) coat of synthetic enamel paint of approved colour over a coat of priming on plaster wall or ceiling surface where necessary in accordance with this specification.

## Construction Requirement

The plaster surface shall be painted with two coats or more of synthetic enamel ready mixed paint of best quality and approved color. *Before* application the surface shall be given a through rub down to remove all loose materials and all cracks and surface irregularities shall be repaired with patching plaster and filler to obtain a smooth and even surface. The paint shall be applied on appropriate primer after the surface has been finished with filler/putty, etc.

Before applying the paint on plastered surface the surfaces must be thoroughly smooth and cleaned from grease dirt and other foreign materials by a use of stiff wire brush, sand papering or other approved means. Painting shall not be carried out in damp weather. No patchy overlap shall be tolerated under any circumstances.

The enamel paint should Robialac (Berger) or equivalent and must be approved by the Project Manager.

Manufacturer's instructions for application for paint must be followed. The colour of the paint

should be according to the direction of the Project Manager.

A sample area must be prepared first and got inspected and approved by the Project Manager before the full scale work commences

#### **5.19.5 French Polishing to Wooden**

##### **Surface Description**

The work covered by this item shall consist of providing French polishing work to wooden surface as per direction of the Project Manager.

##### **Construction Requirement**

French polishing to door frame and shutters three coats over a coat of priming including cleaning finishing and polishing with sand paper etc. all complete in all floor.

#### **5.19.6 Plastic Paint Description**

The work covered under this item shall consist of applying 2 (two) coat of plastic paint of approved color over a coat of priming on plastered wall or ceiling surface where necessary in accordance with these specifications. The painted surface shall be easily washable by soft soap and water.

##### **Materials**

The plastic paint should be Robialac (Berger) or equivalent and must be approved by the Project Manager. The priming consists of appropriate type as specified for the paint by the manufacturer, and shall be applied accordingly.

##### **Application Method**

The surface to be plastic painted shall be dry, well cleaned and free from efflorescence dirt and stain of grease. The surface shall be given a through rub down to remove all loose materials and all cracks and surface irregularities shall be repaired with patching plaster and filler to obtain a smooth and even surface. The mixing of plastic paint shall be carried out in accordance with the instruction issued by the manufacturer of the particular brand of plastic paint that is to be used. Before starting work plastic paint shall be mixed in such way that one room can be finished with same mix. Plastic paint is to be applied with proper brushes as supplied or recommended by the manufacturer. A sample area must be prepared first and get inspected and approved by the Project Manager before the full scale work commences, The paint work shall not be considered as complete till a surface of perfect uniformity in color, shade and texture is achieved.

#### **5.20 Timber Works**

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## Descriptions

The item shall consist of supplying and fixing timber for doors, windows fitted with hardware and finished in accordance with the applicable plans, schedules and these Specifications.

### Construction Requirements for Timber Doors

Timber for shutters, trims and frames shall be Barma Teak, Grounds, studs and blocking shall be in sound Jam or other approved wood. All timber shall be free from sap, shakes, large or loose knots and defects affecting the appearance, strength and durability of construction and shall be well seasoned, dried to moisture content of 6% by weight and treated with non-swelling, non-staining water repellent paintable wood preservative.

**Glue** shall be waterproof approved product consisting of synthetic resin (phenolic, amino plastic or polyvinyl acetate) emulsion adhesives for wood or any other approved materials conforming BS-1204.

**Knotting** shall consist of a uniform dispersion of 25% flake shellac in 75% methylated spirit or other approved natural or synthetic resin in a suitable solvent and conform to BS-1336.

**Stopping** shall be made from white or red lead and sufficient linseed oil to produce a stiff paste and conform to BS-544.

**Hardware** shall be of approved material, finish, type and make and shall be complete with necessary screws, trims and all other accessories required for proper installation. All screws and accessories shall be of suitable size and type and shall match with the pigment as to material and finish.

**Joinery workmanship** shall be of the highest quality. All joints shall be well made, cleanly matched and tight. Verticals shall be plumb. Joints shall be put together with waterproof glue and if necessary further secured with finishing nails of softwood or with screws of hardwood.

Surface shall be finished smooth free from disfiguring defaces such as raised grain, stain, evidence of poor and uneven planning and sanding, tool marks, gouges and scratch.

All edges of woodwork shall be carefully trimmed and the arises eased by rounding to a radius 1.0mm.

**Door frames** in masonry walls shall be installed only after the walls are in place and have been cured.

Styles and rails shall be accurately cut and glued together with close fitting mortise and tenon joints which shall be further pinned with corrosion resisting metal pins of diameter not less than 5 mm or with hard wood pins of diameter not less than 7 mm. The joints shall be such as to ensure complete rigidity of framing throughout.

Panels shall be tongued-and-grooved unless otherwise shown on the plans, Wide flat surfaces

shall be made of several narrow strips glued, dowelled, splined or dovetailed together as required.

All faces of frame buried or hidden in masonry shall be painted with 2 coats of tar paint before erection. The frames shall be installed plumb and fixed to brick masonry with flat iron hold fasts (225×37×6) mm tongued and turned at the ends and to concrete with No. 12- 90 mm long screws with suitable expansion-shields or fiber-lugs. The hold fasts and fixing screws shall be spaced not over 1 meter apart. The screw heads shall be countersunk at least 12 mm below the surface and plugged.

Butt hinges shall be set flush. All hardware shall be installed carefully in correct position strict conformity with the manufacturer's instructions. All hardware, fitting must have previous approval of the Project Manager before using into work.

**Application of surface finishes** shall conform to British Standard Code of practice CP-231.

After erection and before any finish is applied, all woodwork shall be hand-sanded using a succession of grit sizes each removing in turn all the coarser grooves created by the preceding grit. Knots and resinous streaks shall be treated with 2-3 coats of knotting applied evenly and thinly. Nail holes, cracks and cavities shall be filled in with stopping pressed well home with a stopping knife. Large holes or knots shall be plugged in with a mixture of red lead and enamel glue in equal quantities laid hot. Knotting and stopping shall extend slightly beyond the resinous area or cavity on to the adjacent surface.

The final preparation shall be by rubbing down with fine abrasive paper and dusting off with air jet. The sanding shall always follow the line of grain. No cross-grain sanding marks shall be admissible for any finish system on veneered or solid wood members. All wood surfaces shall be kept free of dust, dirt adhesives or other substances which would interfere with normal finishing procedure. Painting shall be done as per specification of respective item. If varnishing is required the following specification shall be followed.

**Oiling** shall be done with linseed oil, either raw or boiled according to whether a flat or glazed surface is required. Unless otherwise specified a mixture of raw and boiled oil shall be used. The oil shall be rubbed into the wood till the surface is dry. The oil shall be applied sparingly and excess removed to avoid a sticky surface.

Lacquer varnish shall consist of a colourless finish of shellac diluted in alcohol. A wash coat of sealer consisting of  $\frac{1}{4}$  Kg cut of shellac shall be applied first and when dry sanded lightly.

For internal works, 2 coats of lacquer consisting of 1 Kg cut of shellac shall be applied from a well charged clean brush which shall be worked on the surface no longer than is necessary to ensure even spreading. For external works 4 coats shall be applied. Each coat of varnish shall be lightly rubbed down with fine steel wool or abrasive paper and dusted before applying the next.

### 5.20.1 Single Leaf Flush Door



## Description

The work covered under this item shall consist of supplying and fitting, fixing single leaf flush door in accordance with applicable plan or same as existing door.

Construction Requirement of single/double (as approved by BREB) leaf flush door

The single/double leaf flush door of approved size of best quality Bangladesh made (as approved) shall be BFIDC or equivalent standard.

## 5.21 Metal

### Works

## Description

The item shall consist of providing installing and finishing in place steel doors & windows with grill, rolling shutters, collapsible gate, ventilators, gates, boundary grill, hand rails or any other items, including frames made of plain steel structural shapes, plates, angles, pipes rods, wire mesh, steel sheet etc. where necessary in accordance with the applicable plans, schedule and these Specifications.

## Construction Requirements

Mild steel pipe shall be of specified size conforming to the requirements of ASTM A3.

Structural steel shall conform to the requirement of ASTM A-36 and shall include plain structural shapes and plates cut to length or fabricated.

Glazing shall be provided with 3mm thick transparent acrylic panes (sheet).

All components of every item of work shall be accurately cut, formed, cast, fitted, welded and finished true to form and dimensions as indicated on the plans and drawings. Unless otherwise specified all welding shall be fillet welding.

All steel surfaces shall receive 2 coats of hard-gloss paint of approved colour over a coat of approved anti-corrosive primer unless otherwise specified. Prior to painting, the surface shall be cleaned of mill scale, rust, oil grease and dirt. Surface not painted to the Project Manager's satisfaction shall be repainted at Contractor's own cost.

### 5.21.1 M.S. Grill

#### Description

The steel frame shall be made of mild steel 12mm square bar as per drawing and design. This is to be fitted at any places as per drawing and direction of the Project Manager.

#### Construction Requirement

The mild steel square bar shall conform of the requirements of ASTM A-53. The structural steel shall conform of the requirement of ASTM A-36. These flat and angle M.S. sections are to be cut to sizes, fabricated, welded (continuous) and to the shape and sizes of the frame as per drawing. This frame shall have two coats of synthetic enamel paint over a coat of approved anticorrosive primer. The enamel paint should be of approved colour. Each frame must have min. 8 nos. of clamps on 3 sides of the frame.

A frame should be prepared and deposited with the Project Manager for his approval. Only after approval the manufacturing should start.

### 5.21.2 Switchyard Structures

The switchyard structures shall be a cost effective combination of galvanized members. galvanized members shall be design/manufactured in accordance with the standard REB specifications or Bangladesh standard .

#### Method of Construction

A truss is a formed structure composed generally of straight members so arranged and fastened together at their ends. The stresses in the members, due to the forces at the joints are either tension or compression. Most of the trusses in practice are composed of a number of triangles formed together.

The plane truss consists of a number of bars jointed together such that they lie in one plane & form a frame-work which is suitable against any type of loading acting in the same plane.

Mild steel work in trusses should be done with mild steel sections of different sizes as per design and drawings. These sections are to be fitted and fixed in positions carefully as per design and drawing with gusset plates, nuts & bolts, rivets or by welding. Then after cleaning the surface adequately two coats of anticorrosive paint over a prime coat of red oxide or red lead shall be applied with appropriate applicator. To determine the number of rivets, must be known the design load, thickness of gusset plate and angles, the sizes of rivets and allowable unit stresses.

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**5.22 Aluminum Doors, Windows etc.****Description**

The works under this item shall consists of supplying and fixing of aluminum products of various types such as doors, windows, curtain walls, curtain rails, cladding/ flushing of sills, etc. fitted with necessary hardware and finished in accordance with applicable drawings and specification.

**Construction Requirements****a) Materials and Products**

Doors, windows, curtain walls etc. shall be of approved standard conforming to the U.S. Architectural Aluminum Manufacturers Association (AAMA) or BT A specifications. The frames and sash members shall be of extruded shape made of 6063 T5 high quality aluminum alloy having a minimum section thickness of 2mm unless otherwise shown on the drawings or indicated in the schedule of items and shall conform to AAMA or BT A standard.

**b) Fasteners, Hardware and anchors**

Fasteners, hardware and anchors shall be of aluminum or non-magnetic, non-corrosive material compatible with aluminum, All windows shall be provided with non-jamming latches of rocker type designed to be locked from inside. Window locks shall be flush type as manufactured by the Adams Rite Manufacturing Company of Gleudale, California or approved equivalent. The doors shall be provided with cylindrical locks and suitable built-in non jumping latches and bolts.

Security locks shall be pin type mortise lock, 6 or 7 pins and adaptable to Master, Grand master and Great Grand Master keys. Sliding windows and doors shall be fitted with adjustable sealed bearing sheaves of durable hydrated nylon or approved equivalent. Closers Push/pull and kick plates shall have to match with the frames. Any other hard wares to be incorporated in the work shall also match with the frame. Assembly and installation screws shall be of stainless steel. Doors, Windows, curtain walls etc. shall be installed with teflon injected expanding bolts, Sills shall contain adequate provisions for drainage. Head, sills and jamb members shall be of one piece construction. Aluminum to aluminum contact between hardware parts or moving members shall not be permitted. Such contacts shall be properly insulated.

**c) Glass Pane**

Glass shall be 6mm thick tinted dark bronze float glass panes (Japan, Bangladesh or Equivalent). Or as per drawing, schedule of item and direction of the Project Manager.

**d) Glazing Beads**

Glazing beads shall be aluminum shape-in interchangeable type.

**e) Glazing Strips**

Glazing strips or channels shall be of formed neoprene of acceptable quality.

**f) Weather Stripping**

Weather stripping shall be of neoprene or silicon treated woven wood or approved equal.

**g) Joints**

Joints shall be mechanically done square (telescopic) joints. No mitred Joints shall be accepted. No forced fitting shall be accepted. All units shall be fabricated at the factory to accurate dimensions.

It shall be rigid and designed to permit complete weather stripping. In principle, the parts should be put together by self-tapping screws.

**h) Surface Finish**

All exposed surfaces of aluminum members shall be factory finish and of substantially uniform appearance conforming to "Architectural" standard.

All exposed surfaces shall be given a natural Anodic Oxide hardcore coating of 15 micron in thickness and a density of 25mg. per square inch and a uniform color tone conforming to the U.S. Aluminum Association or equivalent standard. The color spectrum shall be natural silver/approved shade of bronze or all exposed surfaces of the Aluminum frames shall be electrostatically painted with VV resistance hard resin powder with minimum coating thickness of 40 micron of approved color shade. Finish of hardware shall match closely with the door/window/curtain wall finish.

**i) Accessories**

Accessories necessary for proper fixing and preparation such as anchors, clips, fins, sub-frames, metal sills, mullion, covers, casing, other trim, cleaning anchors, glazing beads, weathering and glazing strips, hardware and mechanical operators shall be supplied ready to set in place with the door, window, curtain wall units.

Steel or wood sub frames shall be painted with Zinc-chromatic primer in case of steel and' with wood preservative in case of wood. Steel anchor shall be properly insulated from aluminum frame.

**j) Sealant**

Sealant shall be one part elastic compound of "Architectural" grade caulk and shall be in matching color or as approved by the Project Manager.

### **k) Shop Drawings**

The Contractor shall prepare detailed design of all work involved in line with the Consultants design and prepare Shop Drawings for the total work and submit to the Project Manager for approval before factory fabrication. All exterior doors, windows and curtain walls shall be designed to withstand a wind pressure of 30lb/sft.

### **l) Installation**

All units shall be assembled at site under proper conditions, erected, fixed and glazed in place in strict conformity with manufacturer's instruction. All cut-out operations for hardware preparation shall be made accurately and reinforced as required.

All doors, windows, curtain walls etc. shall be set plumb, square, level and in exact alignment with surrounding works and shall be securely anchored ready for operation. All joints between the masonry openings and frames shall be caulked and sealed after installation of the frames. All installation works shall be done and finished in such a way as to ensure a free and smooth operation.

Abrasion or other injury to finished surfaces shall be carefully avoided. Cleaning should be accomplished with plain water or a petroleum type cleaning agent or with the manufacturer's recommended cleaning reagent. No corrosive reagent shall be used.

## **5.23 Water Proofing Polythene**

### **Sheet Description**

The work covered under this item shall consist of supplying and laying in place polythene sheets over brick flat soling in floor of buildings and where needed in accordance with the applicable Plans, Schedules and Specification.

### **Construction Requirement**

The sheets shall be laid within the building covering the entire inside floor area. Before laying the sheets the brick surface shall be cleaned with a duster to give the surface a free of extraneous particles. The sheets shall be free of damage, tear or other imperfection and shall be laid such that there is a minimum of 225 mm overlap between, adjacent strips. The second layer shall be laid over the first in the same direction but with a stagger of half the strip width.

## **5.24 Lime Terracing on**

### **Roof Description**

The item shall consist of constructing a layer of lime concrete 2:2:7 on roof slabs in accordance with these Specifications.

## Construction Requirements

Lime concrete shall consist of a mixture of 2 parts lime to 2 parts surki and 7 parts brick chips.

Lime shall be unslaked lime and shall be mixed by weight. Lime weight shall be measured at Unslaked Condition and one cubic meter of lime terracing work requires 4.60 mounds (172.16 kg) of lime. Slaked lime shall be screened through 3.35 mm sieves and the residue shall be rejected. The lime stone should be brought to site and slaked in the ground of the working place.

Surki shall be made from 1st class (well-burnt but not vitrified) bricks crushed or ground to pass through a 2 mm sq mesh.

Brick chips (khoa) shall consist of 18 mm down-graded angular fragments of broken or crushed 1st class bricks.

The mixing shall be done on a clean platform but not on roof. Lime and surki in the specified quantities shall first be mixed dry till the mixture is of uniform colour. Then the mixture shall be screened. Specified quantity of previously wetted khoa shall be added and the whole turned over once without adding water and twice by gradually adding small quantities of water for tempering. The mix shall then be allowed to age for at least 7 days. During this period the mixture shall be turned by spading twice a day and further lime water added if needed to prevent drying up. Care should be taken to keep it under cover to protect against rain. The mixture shall then be laid evenly on the roof slab to proper slope and in thickness 30% more than that shown on the plans and thoroughly beaten for 7 days with wooden mallets to the finished thickness and proper slope. Before beating a lime slurry shall be laid on the top and allowed to soak well. The lime water mixed with molasses shall be continually sprinkled on the concrete to keep it wet while being beaten. Beating should not be stopped until the metallic sound is obtained. The mortar which comes to the surface during the beating is to be rendered smooth and finished off with lime rubbing. The terracing shall be kept wet after completion for a period of not less than one week. The soundness of the lime terrace roof should be tested by cutting a small portion of the materials 75 mm square and 50 mm deep in few representative areas and filling the holes with water and observing for half an hour. If the water level does not go down in any of the holes the compaction of the L.C. shall be considered to have been adequate. If not, the L.C. shall have to be done again.

### 5.25 Screeding on

#### Roof Description

Average 50mm thick screeding with concrete on top of roof slab with cement, sand (FM 2.5) & 12mm downgraded stone chips. Concrete is to be laid in slope as per drawing and direction of the Project Manager.

### 5.26 Surface Drain/master drain

## Description

The item shall consist of 300 mm or 450 mm deep RCC drains in accordance with these specifications.

### Construction Requirement

Bricks, cement, sand and all other materials shall conform to the requirement of respective materials specified in the relevant sections of materials specifications.

The surface drain shall be constructed in true line and level as per drawing and direction of the Project Manager.

300 mm deep drains shall have 300 mm clear width with 125 mm thick brick wall (1:6) on 75 mm thick cement concrete (1:3:6) base over single layer brick flat soling. The exposed surface shall have 12 mm thick cement plaster (1:3) with neat cement finishing and curing at least for 7 days must be done.

## 5.27 Apron

n

### Description

The item shall consist of construction 50 mm thick cement concrete over a layer of Brick flat soling around the structure in accordance to this specification.

### Construction Requirements:

Cement Concrete (1:2:4) with neat cement finishing.

Brick flat soling by first class bricks unless otherwise specified.

Sand shall be clean well graded natural sand having F.M of 2.0 for concrete. Water

shall be same as required for concrete.

The area specified for construction of apron shall be thoroughly cleaned, leveled & compacted to proper slope & level. Brick flat soling shall be laid over compacted earth according to specification no. 2.6, then cement concrete (1:2:4) as per specification no. 2.7 shall be placed over BFS with maintaining proper level & slope towards drain, Simultaneously neat cement finish shall be applied on top surface curing for a period of at least 7 days as prescribed in item no. 2.7 complete as per drawing & direction to the Project Manager.

## 5.28 Road Work

The proposed substation sites are located in different parts of Bangladesh. These are the low lying area mostly are paddy land. The proposed substation sites may be connected by a road which shall be constructed during construction period.

The Construction work of roads shall be carried out in accordance with the Drawing. The design and drawing shall be as per AASHTO specification. However, demolition and restoration of the public roads (including private roads) shall be carried out according to the specifications designated the official in charge of road management notwithstanding the provisions described in the specifications and the Drawing.

### **5.28.1 Road Work Inside The**

#### **Premises Sub-grade**

- a) Any excavation and banking work required for sub-grade construction shall be carried out in accordance with the respective provisions in General Provision of earth work.
- b) The material required for banking and displacement shall be so placed that the finished thickness of one layer after compaction shall become 20 cm or less.
- c) The sub-grade surface shall be finished by proof-rolling in order to obtain the contact pressure sufficient to permit smooth traffic of vehicles of 8 tons or over should any defects be detected as a result of proof-rolling, such defective sub-grade surface shall be finished again to the satisfaction of the Project Manager.
- d) The finished sub-grade surface shall be within + 5 cm of the design elevation.

#### **Sub base Course**

- (a) The materials to be used for sub base course shall be in accordance with the specification described in the Drawing. The Contractor shall submit a report concerning the quality of materials and the methods of sampling to the Project Manager for approval.
- (b) The finished surface of sub base course shall be within –10 mm and +5mm of the design elevation.

#### **Surface Course (Asphalt pavement) – Approach/Access Roads**

- (a) Prior to commencing pavement, the sides of concrete side walk, manhole, etc. shall be cleaned, and molten asphalt, etc. shall be coated over the sides.
- (b) The surface to be seal-coated and prime-coated shall be finished into even level, and after perfecting removing any bloc, dust and other foreign matters, such surface shall be cured and dried.
- (c) The mixtures shall be spread uniformly, rolled and finished into the specified thickness. Then, the finished surface shall be measured in parallel to the center line of the road by using a 3 m straight line ruler. In this case, the depth of any concave sections shall not exceed 5 mm.
- (d) The Contractor shall submit a report on the materials to be used for pavement of surface course and method thereof to the Project Manager for approval.

### **Inspection**

The Contractor shall invite inspection by the Project Manager during the course and after completion of sub base course and surface course works.



### 5.28.2 Public Road (Including Private Road)

(1) Demolition of Pavement

Demolition of Pavement for public roads including private roads shall be carried out so carefully as not to cause any hazardous effect upon the surrounding portions of cement, concrete or pavement.

(2) Road Keeping and Restoration

(3) The road keeping shall be of a construction applicable to the prevailing site conditions and so provided as not to cause any danger or trouble against traffic.

(4) The Contractor shall submit the drawings for road keeping to the Project Manager for approval.

(5) The Contractor shall constantly patrol any spots of road keeping and exert his utmost efforts perform maintenance and repair of such roads in order to eliminate any trouble against smooth traffic.

(6) The Contractor shall carry out maintenance and repair of any pertinent roads so carefully as not to cause any trouble against smooth traffic until the said roads have been restored and taken over to the official in charge of road management.

### 5.28.3 Herring Bone Bond Brick

#### Pavement Description

This work shall consist of a base composed of bricks, laid on edge in a herring bone pattern, placed on a prepared single layer brick flat soling in accordance with these specifications and to the lines, grades, levels, dimensions and cross section shown in the drawings and as required by the Project Manager.

#### Materials

The materials shall consist of first-class bricks.

#### Construction Methods

The bricks shall be laid either flat or on edge with the shortest side vertical , in a single layer in a herring bone pattern to the lines, grades, levels, dimensions and cross section shown on the drawings and as required by the Project Manager. The edges/lines of the layer shall be made with cut bricks to produce a line which is compatible with brick soling. The joints shall be filled with sand brushed in and the completed layer shall be sprinkle liberally with water.

#### **5.28.4 RCC Pavement – Internal Roads.**

##### **Description**

The item shall consist of constructing R. c.c. road with 250mm thick guid wall of height 0.30 meter and 150mm thick R.C.C. work over one layer first class brick flat soling and reinforcement 10mm dia M.S. rod @ 175mm c/c in both direction.

##### **Reinforcement**

In pavement shall be placed and secured as shown on the plans in accordance with the requirements of item 2.12.

##### **Construction and expansion joints**

Shall be constructed exactly in accordance with the details shown on plans and with best workmanship and as per direction of the Project Manager.

Extreme care shall be exercised in placing, compacting and finishing concrete at the joints to prevent displacement of the joints and to avoid the formation of honeycombs and voids. The concrete along the joints shall be thoroughly consolidated by the use of vibrators.

As soon as the concrete is sufficiently hardened, the edges of the pavement, the longitudinal joints, the construction, and expansion joints shall be carefully executed as per drawing and direction and finished with an edging tool so that the radius shown on the plans is obtained.

##### **Curing and protection**

Shall start as soon as newly-laid pavement is sufficiently, hardened and shall be continued for a period of at least 7 days as prescribed in item no. 2.10

After hardening of concrete the joints shall be cleaned and filled with sand bituminous mastic to the satisfaction of the Project Manager.

#### **5.28.5 Laying of Curb Stone (Concrete**

##### **Block) Description**

The work covered by this item shall consist of providing and laying curb stone in sidewalks, driveways, road islands, garden paths, parking areas, etc. as per manufacturer specification, drawings and direction of the Project Manager.

##### **Materials**

Materials shall meet requirements specified below and in accordance with the specifications. Curb stone shall be with concrete class C18.

The mortar for joining shall be 1:2 cement mortar.

## **Installation Requirements**

Preparation of bed, laying and joining shall be as per manufacturer specification.

### **5.29 Clearing after Completion**

The Contractor shall thoroughly clean all work upon completion. Clean off all stains, marks, spots, and disfigurements from all works, touch up as required, clean all window panes, remove all rubbish and debris from building and site and leave premises clean and tidy and fit for occupation in all respects and to the entire satisfaction of the Project Manager.

### **5.30 AS Built Drawings**

The Contractor shall prepare as-built drawings for entire project after completion of Construction, installation and all tests, and obtain approval from Owner/Consultant, and shall submit 3 (three) set of such as-built drawing to the Owner for keeping record. Minimum one computer soft-copy shall be accompanied with the as-built drawings.

### **5.31 Tests for Materials**

The following tests for the construction materials shall be performed.

#### **5.31.1 Sand**

At least two samples shall be tested for each consignment but not exceeding 275 cum.

- a) FM
- b) Percentage of clay lump
- c) Mica content
- d) Organic Impurities
- e) Material finer than # 200

#### **5.31.2 Brick**

At least 6 bricks to be tested for each consignment not exceeding 50,000 no. of brick.

- a) Unit weight
- b) Compressive strength
- c) Water absorption
- d) Dimensions
- e) Efflorescence, if necessary

**5.31.3 Reinforcement**

Each set of sample shall consist of 3 (three) representation standard places of Deformed bar for each size for each consignment or as directed and shall be tested for the following properties:

- a) Yield or 0.2% Proof strength test
- b) Ultimate tensile strength test
- c) Elongation
- d) Bend test
- e) Cross section area
- f) Unit Weight/meter

**5.31.4 Stone Chips**

At least two samples shall be tested for each consignment but not exceeding 600 cum.

- a) Gradation
- b) Unit weight
- c) Specific Gravity
- d) Los Angeles Abrasion Test.

**5.31.5 Cement**

At least 3 samples of cement shall be tested for each consignment but not exceeding 100 tons.

- a) Fineness
- b) Setting times
- b) Compressive strength for 3rd, 7th and 28th day

**5.31.6 Concrete**

For all concrete work at least 3 (three) sets of 3 (three) samples cylinder/cubes and for each days casting or for each 15 cum of concrete shall be preserved and tested to for 7 days and 28 days crushing strength.

**5.31.7 Water**

Sulphate and Chloride content shall be tested for construction works of each site.

**5.31.8 Where Tests to be Done**

All tests shall be performed in the BRTC of BUET or any other laboratory approved by the Project Manager.

**5.31.9 Cost of Tests**

The cost of making any test shall be borne by the Contractor if such test is clearly intended by or provided for in the specifications or Bill of quantities and is required to ascertain whether the design of and / or quality of any finished or partially finished work is appropriate for the purposes which it was intended to fulfill and conforms to specifications.

**5.31.10 Building Furniture**

The required building furniture is listed on the drawings. The final specification of the supplied furniture shall be to the approval of the Project Manager.

## **B. CIVIL**

### **6.0 BUILDING, SANITARY AND ANCILLARY FACILITIES**

**TABLE OF CONTENTS**

| <b>Clause No.</b> | <b>Description</b>                     | <b>Page No</b> |
|-------------------|----------------------------------------|----------------|
| 6.1               | Plumbing Fixtures                      | 391            |
| 6.2               | Wash Basins                            | 391            |
| 6.3               | Kitchen Sink                           | 392            |
| 6.4               | Soap Tray                              | 392            |
| 6.5               | Toilet Paper Holder                    | 392            |
| 6.6               | Glass Shelf                            | 393            |
| 6.7               | Towel Rails                            | 393            |
| 6.8               | Mirrors                                | 393            |
| 6.9               | Shower Rose                            | 393            |
| 6.10              | CP Grating                             | 394            |
| 6.11              | CP Bib Cock                            | 394            |
| 6.12              | CP Stop Cock                           | 39             |
| 6.13              | G.I. Water Pipes and Fire Stand Pipes  | 394            |
| 6.14              | PVC Sewer Pipes and Fittings           | 396            |
| 6.15              | UPVC Soil and Waste Pipes and Fittings | 396            |
| 6.16              | RCC Pipes                              | 397            |
| 6.17              | Inspection Chambers with R.C.C. Cover  | 398            |
| 6.18              | Water Tank                             | 399            |
| 6.19              | Water Pump                             | 399            |

## 6.1 Plumbing Fixtures

### 6.1.1 Water

#### Closets Description

The work shall be covered by this item shall consist of furnishing and installing white-glazed vitreous China water closet (WC) long pan/commode/Combi closet in accordance with these specifications.

#### Construction Requirements

Water closet (commode/Combi closet) shall be "S" or "P" type with low down cistern of vitreous China and shall be standard product of Bangladesh Insulator and Sanitary ware Factory (BISF) Ltd/International- standard complete with seat and cover shall be made of formaldehyde molding compound of VICTORY brand/ equivalent of approved quality. Size of commode shall be as per requirements of schedule of item.

**Long Pan** Shall be squat type as per BISF/ International -standard with integrated foot rests and shall be as specified in schedule of item.

**Low down** Cistern for commode/Combi closet/long pan shall be BISF/ International standard quality cistern of size 550mm x 260mm x 375mm and capacity 12.00 liters.

**Cistern** For long pan shall be overhead 13 liters type (MAANCO/ BISF/ International Standard or approved equivalent) complete with float valve, fittings and fixtures as per requirements of schedule of item.

**Angle stop** shall be as per drawing and instruction.

**Pans** shall be fixed to the floor with 1:2 cement mortar in case of squat type and with 4 nos. CP round headed screws in case of pedestal type.

**Cistern** shall be secured to the wall by 2 nos. #14 CP round headed screws and supported on centre bracket fixed to the wall with 2 nos. #14 CP countersunk screws. Cistern shall be connected to water supply with 12 mm plastic connecting pipe and CP angle stop.

## 6.2 Wash

### Basins

#### Description

The work shall be covered by this item shall consist of furnishing and installing white-glazed vitreous China wash basin on wall and supported by concealed wall hangers and fitted with chrome-plated 30 mm waste, bottle trap and waste pipe, 12 mm angle stop and pillar faucet, chain, stay, rubber plug and 12 mm plastic supply connector pipe in accordance with these specifications.

## Construction Requirement

Wash basin shall be of BISF-standard colour and size as specified in schedule of items.

Pillar faucets and angles stops shall be 12mm bore chrome plated brass and be of best quality (king size) Bangladesh made prior approved.

Traps (Syphone : dismantle type) shall be 30mm bore Chrome plated copper alloy having at least 75mm water seal and shall be priority approved best quality Bangladesh made.

Waste pipe shall be of 30mm. PYC pipe best quality available for sewer grade.

Basins shall be supported on 2 concealed wall hangers. The basin in the executive/Master toilet room shall be provided with pedestal: 652mm x 204mm x 204mm size BISF standard coloured.

Hangers shall be screwed to hardwood plugs built in the wall using 3 nos 14 countersunk screws for each hanger. Hangers shall be painted with 2 coats of oil paint, over a coat of red lead primer or shall be galvanized.

Taps, valves and traps shall be connected with water supply installation by means of standard unions, coupling nuts and fittings.

### 6.3 Kitchen

#### Sink Description

The work covered by this item shall consist of furnishing and installing Kitchen sink and tray on bracket in accordance with these specifications.

#### Construction Requirements

Kitchen sink and tray shall be Stainless Steel as per requirements of schedule of items. The construction requirement shall be similar to Wash Basin.

### 6.4 Soap

#### Tray

#### Description

This item covers the supply and installation of soap tray as per following requirement.

#### Requirements

The soap tray shall be C. P. cast iron of standard size best quality Bangladesh made (as approved) and should be fixed in wall by drilling & fixing by screws etc. all complete. The dimension shall be 150mm x 110mm x 40mm.



## **6.5 Toilet Paper**

### **Holder Description**

The work covered by this item shall consist of furnishing and installing Toilet paper holder in accordance with these specifications.

### **Construction Requirements**

Toilet paper holder shall be of approved quality as specified in schedule of item. The holder shall be fixed with chrome plated brass screws to plugs built in the wall.

## **6.6 Glass**

### **Shelf**

#### **Description**

This item shall cover supply and installation of glass shelf 5mm as per schedule of item fm: basins & toilets as per following requirements.

#### **Requirements**

The glass shelf shall be best quality local made (Priority approved) with C. P. or stainless-steel supports & guide rails and should be fitted in the wall with screws etc. complete.

## **6.7 Towel**

### **Rails**

#### **Description**

The work covered by this item shall consist of supply of towel rails and installation of the same as per following requirements.

#### **Requirements**

The towel rails shall be chromium plated heavy type 20mm dia 600mm long with C. P. flanged holder, counter sunk screws. The rail should be fixed in walls by drilling holes in wall, fixing screws through rowel plug to the satisfaction of the Project Manager.

## **6.8 Mirrors**

### **Description**

The work covered by this item shall consist of furnishing and installing plate glass mirrors Japan/Belgium/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer) of approximate dimensions 450 mm x 350 mm and of 5 mm thickness over lavatory basins according to these specifications.

## **Construction requirements**

Edges of mirror shall be clean cut and round smooth. Mirror shall not be installed in direct contact with the wall. The separation shall be effected by 6 mm thick rubber or cork spacers. Fixing shall be by means of chrome-plated holders and screws to hardwood plugs built in the wall. Care shall be taken to place the mirror symmetrical to the axis of the basin and with sides vertical and horizontal.

### **6.9 Shower**

#### **Rose Description**

The item shall consist of furnishing and installing chrome plated brass shower rose in accordance with these specifications.

#### **Construction Requirements**

The shower rose shall be of nominal 100 mm diameter best quality Bangladesh made prior approved and shall be connected to the water supply installation by screwing giving a leak-proof joint.

### **6.10 CP**

#### **Grating**

#### **Description**

The work covered by this item shall consist of furnishing and installing chrome-plate gratings in accordance with these specifications.

#### **Construction Requirements**

CP grating shall be 125mm dia. heavy type and approved quality and shall be installed in direct contact with the floor.

### **6.11 CP Bib**

#### **Cock Description**

The item shall consist of furnishing and installing chrome-plated brass bib taps in accordance with these Specifications.

#### **Construction Requirements**

Bib taps shall be of 12mm bore heavy type with at least 75 mm projection and shall be best quality Bangladesh made (Nazma, Sharif or equivalent) prior approved Draw-off taps and stop valves for water services!

Taps shall be connected with the water supply installation by means of standard unions, coupling nuts and fittings.

## **6.12 CP Stop**

### **Cock Description**

The work covered by this item shall consist of furnishing and installing chrome-plate stop cocks in accordance with these specifications.

### **Construction Requirements**

The stop cock shall be 12mm dia heavy duty chrome-plated concealed and shall be approved quality Bangladesh made (Nazma, Sharif or equivalent).

Stop cock shall be connected with the water supply installation by means of standard unions, coupling nuts and fittings,

## **6.13 G.I. Water Pipes and Fire Stand**

### **Pipes Description**

The work covered by this item shall consist of supplying and installing galvanized steel water pipes on wall surface or in wall, underground through stack (duct) and where necessary in accordance with these specifications.

### **Constructional Requirements**

GI pipes shall be galvanized steel welded tubes of screwed and socketed type, Class A and shall be equivalent to as specified in BS-1387.

### **Stop valves**

Shall be of brass and equivalent of the screw down pattern conforming to as specified in BS-1953.

### **Draining**

Staps shall be screw-down pattern conforming to BS-2879.

### **Ball valve**

Shall be of brass and conform to BS- 1212.

### **Float for ball valve**

Shall be of copper with solder joints and conform to the requirements of Class A, BS-1968. All

fittings shall be standard GI products and shall conform to BS-534.

The piping work shall be carried out in accordance with British Standard Code of Practice CP-310 Water Supply!

Pipes shall be jointed with preferably with raplon tape according to manufacturer's instructions. However, strands of fine jute may be used with the approval of the Project Manager.

A gate valve along with a float valve shall be provided with a socket union where the service pipe from main is connected to the underground reservoir.

Stop valve shall be provided on the supply pipe to individual buildings in an accessible position inside the building as near as practicable to the point of entry of the pipe to each building so that the supply may be readily shut off for repairs. A draining tap shall be provided just above the stop valve to enable the service piping in the building to be emptied of water when stop valve is shut. Stop valve shall also be provided at the outlet from roof storage tank and on every branch pipe of the feed pipe as near as possible to the point at which the pipe leaves so as to minimize interruption of supply during repairs.

Where the service pipe is less than 50 mm bore, all the stop valves shall be of the screw down type. Other stop valves shall be of the gate type.

Pipe in structures shall be installed during construction. No hole or chasing in wall or floor shall be allowed without prior approval. Pipes shall be supported by steel clips placed at an interval of approximately 1 meter. All clips and brackets shall be fixed with rawal plugs into the masonry.

The fire stand pipe shall be 4" dia G.I. unless otherwise specified. Each floor shall be equipped with fire hose, made of rubber lined cotton 63mm diameter. Rubber covered or unlined linen may be provided with the approval of the Project Manager. A closet in which hose is stored should be ventilated and installed at least 1300mm above the finished floor. The hose is to be equipped with 25 to 33mm nozzle.

The joint shall be made with hose coupling. The length 63mm hose should be about 30m. This length, measured around obstruction and partitions, should make possible the use of nozzle within 10m of every part of every floor in the building. Two such closets with hose are to be provided for each floor in each tower as shown in the drawing.

A hose valve is to be installed close to the water supply pipe (stand pipe) between it and the hose. The gate valve so equipped shall have thread that are interchangeable with those used by the local fire department.

Since the stand pipes in the building are supplied from roof tank, they are to be linter connected at the top as shown in the drawing.

Fire department hose connections shall be provided with an approved straight may check valve located in the value pit (or the building), but not with a gate valve. Check valve shall be of the approved extra heavy flanged pattern or as required by the local fire department.

Piping outside building shall be laid underground and the depth of cover measured from the top of the pipe to the finished surface of the ground shall not be less than 750 mm where the pipe passes under roadways or through structures, a min. 100 mm RCC sleeve shall be fixed to allow freedom of movement.

The Contractor shall carry out and provide as part of the contract all excavation in any kind of soil encountered for laying pipes to the required depths. No tunneling shall be done except with the consent of the Project Manager. Where necessary the Contractor shall support the sides of the pipe trench by suitable timbering, bail out water, remove spoil and backfill to make up level with sand FM 1.0 without extra cost. Backfilling shall be carried out as provided under item 2.5.2 of Spec. civil.

After installation the pipe system shall be hydraulically tested for two hours at a pressure. equal to 50 psi without showing any sign of leakage.

#### **6.14 PVC Sewer Pipes and**

##### **Fittings Description**

This item shall cover the supply & installation of PVC for conveying away soil water from sanitary filaments, waste and rain water pipes with supply of fittings as may be necessary according to the following requirement.

##### **Requirement**

The PVC waste and rain water pipes & fittings shall comply with ASTM D2729-89 for different diameters and joints should be made to comply with ASTM D267289, ASTM D2855. Pipes shall be jointed to each other by using suitable solvent cement recommended by the manufactures. Installation of PVC pipes indirect sunlight is not permitted. Once the joints are made, they should be left undisturbed for 12 hours for the solvent cement joints to attain its strength.

#### **6.15 UPVC Soil and Waste Pipes and**

##### **Fittings Description**

The item shall consist of supplying and laying cast-iron pipes for conveying away soil water from sanitary filaments.

##### **Construction Requirement**

Cast-iron pipes, shall be equivalent to that specified in BS-416 'Cast -iron spigot and socket soil waste and ventilating pipes (sand cast and spun) fittings and accessories;

The sanitary pipe work shall comply with British Standard code of practice CP-304.

All pipes shall be aligned properly, laid to specified slope (1 in 100) and securely fixed to the structure above the false ceiling by using ears on pipe sockets or cast-iron/G.I. holder bars or purpose made straps.

Cast-iron spigot and socket pipes shall be joined to each other with tarred-jute packed in half the depth of tile socket, while the other half shall be filled in with molten lead properly caulked and furnished. All joints shall be made perfectly air and water tight. Joints shall not be embedded in the structure without prior approval. All pipes to be furnished with cement grouting internally and to be bituminous painted externally.

All junctions shall have back or side door for inspection and clearing.

All necessary fittings such as cowls, gratings, bends, tees (plain or door), offsets (plain and door), sockets, traps, Y -Tees (plain and door), loops, and siphon with horn shall be furnished and fixed at no additional cost to the Contract.

Traps shall have a minimum water seal of 75 mm for pipes up to and including 50 mm dia and minimum water seal of 50 mm for pipes over 50 mm dia. Floor channel drain shall have properly trapped outlet fitted with a removable grating. After installation, water seal tests are to be made to check against any leakage before backfill.

## **6.16 RCC**

### **Pipes**

#### **Description**

The item shall consist of supplying and laying underground reinforced cement concrete pipes for sewerage and drainage and connecting to existing sewer or to the septic tank in accordance with these Specifications.

#### **Construction Requirements**

Concrete pipes shall have a minimum barrel thickness of 14 mm and conform to BS. 556.

Granular bedding shall consist of 12 mm down-graded brick chips.

Cement shall be Portland cement Type-I ASTM C-150, or BS-12

The work shall be carried out in accordance with British standard code of practice CP-301 'Building Drainage' and CP-2005 Sewerage. Pipes shall be laid in trenches at depths and slopes shown on plans. Unless otherwise specified the pipes shall have a slope of 2%. The pipes shall be laid in a straight line and at one gradient between manholes. No bend pipe shall be allowed. Inspection chamber shall be provided at all change of direction and gradient on pipe except where such change is not too large for cleaning. Manholes or inspection chambers shall also be provided at all pipe junctions where cleaning is not otherwise possible. The distance between the access points in no. case shall exceed 50 meters. All branch pipes shall meet with the main line at manholes. No branch shall be permitted to enter into the main without inspection chamber.

The Centre line and width of trench shall be accurately set out established by means of suitable pegs and reference points. Where the width of the trench is not specified it shall be 300mm greater than the external diameter of the pipe.

No less than 3 sight rails shall always be fixed by appropriate surveying method on each length of trench at any gradient to control excavation and laying.

The trench bottom shall always be kept free from water by suitable drainage and dewatering if necessary and the walls shall be supported by adequate timbering where so required. Excavated material shall be deposited at a safe distance from the edge of the trench so as not to endanger the stability of excavation. All pipes, ducts cables, mains or other services exposed in the trench shall be effectively supported by suitable means.

Where works are to be executed in the public highway, excavation shall be arranged in agreement with proper authority so as to cause the minimum obstruction to traffic. Proper warning and directions to traffic shall be given.

Trench shall be excavated and trimmed to a depth 150 mm below the invert level of the pipe. Pipes shall be laid on granular bed which shall extend to the full width of the trench to a thickness of 150 mm and adjusted to ensure exact line, level and uniform bearing. If the formation is in-advertently low at any point, it shall be brought up to the correct level by granular fill to ensure uniformity of pipe support. Soft spots, obstructions, and large roots shall be removed and tamped-in solid with approved fill to the satisfaction of the Project Manager with additional cost of material.

In short connection runs, where the ground is not wet and allows the trench formation to be trimmed so as to provide a uniform and solid bearing, the pipes may be laid upon the formation directly. The pipes shall be mortar-jointed using a 1:3 cement-sand mortar. Before mortar is inserted, a gasket of tarred yarn shall be caulked into the joint. Ends of the pipe shall be wetted immediately before jointing. Newly made joints shall be kept damp and protected from weather and disturbance until covered by the backfill. The interior of the pipe shall be examined as each joint is made and any intrusion of mortar or gasket removed. Where it is necessary to cut pipes, this shall be done with a suitable tool so as to leave a clean end, square to the axis of the pipe.

Connection to the existing sewer and excavation around it shall be done only with express consent and in accordance with the instructions of the local authority. After installation, water seal tests are to be made without showing any leakage before backfill.

Backfilling shall be with sand F.M 1.0 built up in layers not exceeding 150 mm. Filling shall proceed downhill and in all other respect comply with the provisions of item 2.5.2 of Spec. civil.

All surplus excavated material shall be disposed of to the satisfaction of the Project Manager.

## **6.17 Inspection Chambers with RC.C**

### **Cover Description**

The item shall consist of constructing inspection chambers, on the underground drainage and sewerage lines where necessary, of dimensions as indicated and of suitable depth, in accordance with these specifications.

### **Construction Requirements**

Materials shall conform to the requirements set forth below and in the relevant sections of the Material Specifications.

Bricks shall be 1st class solid bricks.

Cement shall be Portland cement Type-I ASTM C- 150 or BS-12

Stops irons shall be of galvanized malleable cast iron complying with requirement of BS1247 or of mild steel galvanized after manufacture by hot-dip process.

R.C.C cover and frame for manhole shall be of dimensions shown on the plans.

Excavation shall be as stated in item 2.5 of Spec. civil.

Brick flat under base concrete shall be as stated in item 2.6 of Spec. civil. Concrete for base shall be constructed as stated under item 2.10 of Spec. civil.

Brickwork shall be as stated in item 2.13.1 of Spec. civil, & 2.13.2 of Spec. civil constructed of 1st class bricks and (1:4) or (1:5) cement mortar as 'per requirement.

Plaster shall be as stated in item 2.16.1 of Spec. civil, 2.16.2 of Spec. civil and consist of (1:4) or (1:5) cement mortar as per requirement.

Brickwork of chamber shall be built in English bond with watertight joints. The inside shall be rendered with a neat-cement finished 12 mm thick coat of cement plaster and the exterior shall be flush pointed. The cover frame shall be correctly positioned and, cast-in during concreting.

Backfilling shall be done after at least 7 days of curing of brickwork and shall comply with the requirements of item 2.5.2 of Spec. civil unless otherwise permitted to use the excavated material.

## **6.18 Water Tank**

One overhead tank shall be provided for each substation the minimum requirements for which is provided below:

The tank should be of Blow Molded fabrication and should be strong and long lasting with a U. V. Stabilizer. The capacity of the tank shall be 2000 liters (440 Gallon). It should be installed on the concrete roof of the building. It should be capable of withstanding a temperature of 110<sup>0</sup> C.



### 6.19 Water pump

The water pump provided must be of the submersible type and should be capable of functioning satisfactorily under the particular site conditions. As a minimum it should conform to the particulars below:

#### Submersible AC Motor

| Technical Particular's | BREB Specification                                                    |  |
|------------------------|-----------------------------------------------------------------------|--|
| General Description    | Pressure balanced submersible AC motor.                               |  |
| Motor type             | Highly efficient 3 Phase AC motor                                     |  |
| Internal filling       | Water filling                                                         |  |
| Lubrication            | Water lubricated                                                      |  |
| Electronics            | Any electronics must not be inside the submersible motor              |  |
| Bearing                | Water lubricated slide bearing axial bearing: Carbon ceramic          |  |
| Wetted material        | Stainless steel (AISI304 or higher), Rubber (Drinking water approved) |  |
| Voltage                | 3×100V electronically commutated                                      |  |
| Input Voltage          | 440 V                                                                 |  |
| Submersion limit       | 300 M                                                                 |  |
| Rated Power            | Minimum 3.70 KW                                                       |  |
| Rated Speed            | 1150 to 3425 RPM                                                      |  |
| Warranty               | 05 years or above.                                                    |  |
| Efficiency             | 92% or higher                                                         |  |

#### Submersible Pump end

| Technical Particular's                                                    | BREB Specification                                       |  |
|---------------------------------------------------------------------------|----------------------------------------------------------|--|
| General Description                                                       | Submersible multistage centrifugal pump                  |  |
| Back flow protection                                                      | Non return valve                                         |  |
| Dry run protection                                                        | Preset                                                   |  |
| Material                                                                  | Body: Stainless steel (AISI 304) Impeller: SS (AISI 304) |  |
| Maximum flow rate                                                         | 130m <sup>3</sup> /hr.                                   |  |
| Minimum borehole diameter                                                 | 152mm minimum                                            |  |
| Average daily flow at the static head and Bangladesh insulation condition | 200,000 Litres per day.                                  |  |

According to the test result of water should provide & install water treatment plant to remove salinity & Iron and to make drinkable.

Note: In Support of offered Specification, Printed Catalog must be submitted by bidder.

## **B. CIVIL**

### **7.0 INTERNAL AND EXTERNAL ELECTRIFICATION**

**TABLE OF CONTENTS**

| <b>Clause No.</b> | <b>Description</b>                                                 | <b>Page No</b> |
|-------------------|--------------------------------------------------------------------|----------------|
| 7.1               | Scope of Work                                                      | 403            |
| 7.2               | Standard, Code & Regulation                                        | 403            |
| 7.3               | System Structure, Equipment and Installation                       | 404            |
| 7.4               | Main Distribution, Distribution & Sub-Distribution Board (MDB/SDB) | 412            |
| 7.5               | Switch and Switch / Fan Regulator Board                            | 413            |
| 7.6               | Socket/MCB Outlet                                                  | 413            |
| 7.7               | Earthing                                                           | 414            |
| 7.8               | Service Illumination Levels                                        | 415            |
| 7.9               | Power Outlets                                                      | 416            |

## 7.1 Scope of Work

The electrical installation for each site comprises electrical wiring of light, fan, small power, ventilation power, water pump and all other utilities power supply in the substation building, switchyard, guard room and parking area. There shall be two types of power supply 415 V, 240 V 50 Hz i.e., 3-phase 4-wire and single-phase 2 wire.

The Contractor shall have to submit shop drawings on the basis of consultants drawing for the project for each and every item of work. The Contractor shall submit at least one month prior to start of the particular part or parts of their work to the Project Manager for approval. Similarly the brand, country of origin, design and /sample of all equipment, material, fitting etc. as applicable and which are required for the building, either local or imported item shall have to be approved by the Project Manager. Before taking the item at site or before placing order (for imported items) for procurement, manufacturing etc. or shall be carried out without having such approval.

The bidder shall specify brand name, country of origin, model number etc. of all equipment and material and also attach original catalogue with the bid.

Scheduled quantity may vary as per site requirement. Quantity of some items have been shown as unity. These are only for fixing rate, in case these items are required to be executed, to avoid NT (Non-Bided Item).

## 7.2 Standard, Code & Regulation

The installation in general shall be carried out in conformity with the Electricity Rules of the Govt. of Bangladesh, Bangladesh National Building Code [BNBC] and the 16th edition of the Regulation for Electrical Equipment of Buildings of the Institute of Electrical Engineers (U.K), hereinafter referred as I.E.E. wiring Regulations, and the British Standard Code of practice for the relevant works. Any special requirement of the Electrical Inspector, Govt. of Bangladesh or the Power Development Board, Dhaka Electric Supply Authority, Dhaka Electric Supply Company, or the Telegraph and Telephone Board, or any other Legal Authority shall also be complied with no extra cost to the Employer.

The following standards, in addition shall be followed for design, manufacture, installation, testing and commissioning of wiring and the communication system of this project:

|                                                   |      |
|---------------------------------------------------|------|
| Bangladesh National Building Code                 | BNBC |
| International Electro technical Commission        | IEC  |
| Institute of Electrical and Electronics Engineers | IEEE |
| National Electrical Manufacturers Association.    | NEMA |
| German International Standard                     | VDE  |
| International Standard Organization               | ISO  |
| Japan International Standard                      | JIS  |
| British Standard                                  | BS   |

## 7.3 System Structure, Equipment and Installation

### 7.3.1 Conduit Work

#### 7.3.1.1 Metal Conduit

Metal conduits shall conform to B.S. 4568 part 1 & part 2, or B.S. 31:100, and shall be 18 SWG (minimum) thick, either solid drawn or formed and then welded. In the later case, the bore must be free from any burs. The conduits shall be black enameled or galvanized. The steel shall be such that when bends are formed, the conduit shall not break, crack, or be deformed. Appropriate sample shall be submitted prior to installation of conduit.

#### G.I. Conduit

GI conduit shall be used in sized grade as shown on the drawing. Inside surface of the pipe must be free from any burs. All G.I. bends shall be performed and shall be of same materials as the pipe. Recommended specifications of GI pipe are as follows:

| <u>Nominal<br/>pipe size<br/>(mm)</u> | <u>Outside<br/>dia.<br/>(mm)</u> | <u>Inside<br/>dia.<br/>(mm)</u> | <u>Wall<br/>Thickness<br/>(mm)</u> | <u>Weight of<br/>pipe<br/>(kg/m.)</u> |
|---------------------------------------|----------------------------------|---------------------------------|------------------------------------|---------------------------------------|
| 25                                    | 32.875                           | 26.225                          | 3.325                              | 2.50                                  |
| 37.5                                  | 47.5                             | 40.25                           | 3.625                              | 4.05                                  |
| 50                                    | 59.375                           | 51.675                          | 3.85                               | 5.45                                  |
| 62.5                                  | 71.875                           | 61.725                          | 5.075                              | 8.63                                  |
| 75                                    | 87.5                             | 76.7                            | 5.40                               | 11.28                                 |

## Junction box, Pull box, Circular box, etc.

Junction box and pull box should be made of 16 SWG (minimum) galvanized steel sheet or any other materials as directed by the relevant authority depending on where it is installed, and to the satisfaction of the Project Manager, to match with the existing construction in which these are installed. The circular box shall be of brass/PVC. Circular boxes made of aluminum are not acceptable. The cover (metallic or plastic) of the metallic box should be fixed by using countersunk brass screws or galvanized machine screw. Box ears shall be at least 14 SWG, each box (except circular boxes) must have an earth block of copper or brass of appropriate size (minimum), being for one earthing lead, 3/8"x3/8"x3/8" (10mmx10mmx10mm) block with 3/16" (M5) drilled hole and 1/8" (M3) machine screw tapped for 24 t.p.i. where earth continuity conductors shall be screwed in. The circular box shall have at least 1/2" (12mm) long hub.

Appropriate samples shall be submitted prior to installation of these boxes.

### Conduit/Pipe Bends

Wherever possible, instead of using bends, the conduit should be bent to the required angle using pipe bender. The minimum bending radii shall be such as to allow compliance with standard specification for bends in cables, and in addition the inner radii of bends shall not be less than 2.5 times the outside diameter of the conduit.

### Cable Bending Radius

The recommended bending radii are given below:

| <u>Dia. of Conduit</u> | <u>Radius of Bends</u> |
|------------------------|------------------------|
| 20mm                   | 125 mm                 |
| 25mm                   | 150 mm                 |
| 32mm                   | 200mm                  |
| 38mm                   | 225mm                  |

If the situation warrants use of separate bends for conduit shall be made from 18 SWG steel, black enameled or galvanized. Aluminum bends must not be used Brass/PVC bends are acceptable. No inspection bends shall be used and at places where inspection is required, steel boxes shall be used.

Separate bends shall be used only after obtaining approval of the Project Manager.

In case of G.I. pipes, long radius preformed bends of the same materials and of required angle (221/20, 450, 600 & 900) shall be used.

G.I. pipe may be bent to required angle only after obtaining written approval of the Project Manager.

### Conduit Termination and Fittings

At the end of a run, the conduit/G.I. pipe must terminate in a metal box, galvanized or black enameled. When a conduit is terminated in a metal box (except circular boxes), a smooth bore brass/PVC bush or ring bush must be used along with brass lock nuts of the following specification or its metric equivalent:

### LOCK NUT

| Conduit size (mm) | Thickness (mm) | O.D. (mm) | No. of threads |
|-------------------|----------------|-----------|----------------|
| 19                | 1.56           | 28.125    | 3              |
| 25                | 4.68           | 31.25     | 3              |

### BUSH

| Conduit size (mm) | C.D. (mm) | Length (mm) | No. of thread | Length of smooth bore at end (mm) |
|-------------------|-----------|-------------|---------------|-----------------------------------|
| 19                | 21.875    | 8.59        | 4             | 1.95                              |
| 25                | 28.125    | 10.54       | 5             | 2.73                              |

## Installation

### Metal / G.I. Conduit

In general, conduit pipes shall have surface installation at the truss member and shall be placed under the truss member to the satisfaction of the Project Manager.

Conduits of each circuit must be completely erected before any of the cables are drawn in. The pipe run should be continuous throughout its length, and kept straight as far as possible. It should run either horizontally or vertically, and never at an angle. The conduits are to be properly welded with the truss member at 1 Meter spacing using appropriate welding electrode and other consumables. If the pipes are installed exposed in wall/over false ceiling these shall be placed over 10mm space pipe diameter and clamped with saddle or M.S. flat bar 25mmx3mm at 1meter spacing using rope plug/ rowel bolt to the satisfaction of the Project Manager at no extra cost to the Employer.

All pipe runs should be kept clear of gas, air and steam pipes, and pipes of other services. To avoid other service pipes, the pipe should be either routed or set out so that at least 75mm separation is maintained between other pipes and electrical pipes. Conditions other than those stated above, if encountered by the Contractor, must be brought to the notice of the Project Manager for instructions.

Pipes installed in ground / R.CC. Floor shall be placed at the time of construction to the satisfaction of the Project Manager.

Pipes installed in R.CC. Wall and column shall be placed at the time of construction of the wall. No cutting in wall and column shall be allowed without prior approval.



### 7.3.1.2 PVC Conduit

PVC conduit must conform to NEMA TG2 or equivalent designed for installation of reinforcement and before casing in slabs, or exposed. These shall be heavy wall rigid type-40. The minimum dimensions shall be as per schedule of items and bill of quantities.

No PVC fittings shall have wall thickness at any point less than 2mm.

#### Installation

#### PVC Conduit

In general, conduit pipes shall be installed as per item 4.1.3.1. Where PVC conduit uses fittings made of PVC fiber or other insulating materials, these shall be press fitted and then sealed with PVC solvent cement. Where metal fittings are used thread PVC pipe may be made by using the threads on the fittings as a die.

All exposed PVC pipe runs up to a height of 2 Meter from the floor shall be protected by a metal enclosure.

PVC pipes shall be bent either by using a pipe bending guide lines as detailed in item 4.1.3.1 or by using a hot-box bender or by using a flame. In any event, the bending radii shall conform to relevant portion of item 4.1.3.1 and the bend must be well formed and be without reduction in internal diameter.

#### Conduit / Pipe in Floor

All conduit / pipe shall be installed having a slope of 1:1000 towards the floor mounted pull box or cable duct so that condense or leakage water drains out easily to the pull box or cable duct. For runs of more than one conduit in the same floor the direction of slope of different conduits should be decided in such a systematic manner as to ensure an uniform drain out of the leakage. All socket joints shall be made water tight.

No U-bend in floor shall be installed.

### 7.3.2 Cable

#### Work Material:

Single Core Cable:

Single core low voltage cables and conductors shall be as per BS-6004, BS2004 and VDE 0250, 0271. Conductors shall have 450/750 Volt grade (for BYA cable) and 300/500 Volt grade (for BYM cable) of PVC insulation. All cables shall be multi strand type unless otherwise specified. All flexible cables shall be as per BS-6004 unless otherwise specified.

**Multi Core Cables:**

Multi-core low voltage cable shall be PVC insulated PVC sheathed copper conductor, termite proof, made and tested according to VDE 0250 and 0271 with rated voltage being 600/1000V. All cables shall be multi stranded unless otherwise specified.

Cables directly buried in soil shall be steel wire armored (SW A) type.

**Installation:****Cable in Conduit:**

Single core cables are to be installed either in metal or in PVC (water grade) conduit. The conduit size shall be as specified in the drawing. Separate conduit pipe must be used for individual discipline of supply and services cables, for example, normal power, essential power, telephone, paging, fire alarm etc. It must be ensured that cables are not scratched/ damaged during pulling. For long lengths, pull boxes must be used even if not indicated in the drawings. Cable shall not be drawn round more than two 90 degree bends (or their equivalent) between two boxes in serial, and any single bend must not be less than 90°.

**Cable in Tray and Ladder:**

Cables in tray or the ladder shall be installed according to design, specification, and standard and to the satisfaction of the Project Manager. Proper spacing shall be maintained for laying cable. Cables are to be fastened with tray or ladder by appropriate and approved type fasteners.

**Cable in Trench:**

Unless otherwise stated in design and schedule, generally the size of the trench shall be of minimum 825mm-depth and 450 mm width for each cable to be laid. Where more than one cable is to be laid in the trench, the width of the trench is to be increased by 150mm for each extra cable for size below 70-sq. mm and 300mm for bigger size cables.

A cushion of sand (F.M 1.5), 125 mm thick is to be placed over the bed of the trench over which the cables are to be laid.

After laying the cable, first class brick on edge or flat is to be placed as separators in between the cables. After installation of the brick separators, sand filling is to be carried out up to 150 mm from the top of the bigger cable. After sand filling, one layer of first class brick flats are to be placed along the length and breadth of the trench as a protection against injury. The rest of the trench shall be filled with earth, watered and rammed at 150mm layers. Then red plastic sheet of 0.5mm thick shall be placed throughout the trench as an indication that power cable(s) has been laid down. After cables are laid the original ground conditions shall be restored. But if brick pavement, drain, concrete road, or bituminous carpeted road are cut across or damaged, they shall be remedied and

restored to the original specification.

The cable route shall be as direct as possible and shall receive the Project Manager's approval before excavation.

Cables shall always be laid out or laid into the ground through GI pipe of suitable size as decided by the Consultant. No extra cost shall be paid for such pipes. The exposed end of the pipes shall be sealed using PVC or wooden plugs.

Cable marker of approved type shall be provided in the cable trench 300mm below GL level, along the length of laid cable.

GI cable marker shall be installed at every turning point of the trench.

After the cable is laid, it shall be tested by the Contractor in presence of the Project Manager. If the test is unsatisfactory, the cost of all repairs and replacement shall be borne by the Contractor.

All surplus earth shall be removed by the Contractor at their own cost to the indicated places.

Any damage done to any other services by the Contractor for cable laying operations shall be made good by the Contractor, at their own cost.

All chasing and passages necessary for laying of cable indoor or outdoor shall be carried out by the Contractor and the same shall be made good to the satisfaction of the Consultant by the Contractor without any extra charge to the relevant Authority.

When trenches are left open overnight, and where the road shall be cut, the Contractor shall exhibit a suitable danger signal such as banners, red flags and red lamps at his own cost. Temporary arrangement by placing wooden sleepers/steel sheet etc. across the road cutting for vehicular traffic are also to be made by the Contractor at no extra cost. The Contractor shall be wholly responsible for any accident, which may occur due to the negligence of the Contractor.

All excavations shall be filled up in layers with powdered earth and suitably watered and rammed in such a manner that after completion of the work there is no land subsidence. The road top shall be re-constructed to match the existing road pavement.

No trench shall be dug until all cables meant for laying have been procured and brought at site store. Cost of any watering or shuttering and shoring of trench required to be done shall be borne by the Contractor.

### **Road Crossing:**

At road crossings, the cable shall be protected from damages by passing the cable through metal or concrete conduit and protecting that conduit with appropriate road construction.

**Cable Termination and Joint:**

There shall be no twisted joint in the entire wiring system. Cables from 2.5 sq. mm and above sizes shall be terminated through cable lugs and with spring washer, nut etc. Cable gland shall be provided for cable termination at the entrance of boxes, panels, chambers etc. For armoured cables, earth tags shall be provided with cable gland, for connection with system earth or Earth Continuity Conductor (ECC).

**Cable Bending****Radius Refer item****4.1.3.1 Connection to****Switches:**

The Switches or Isolators shall be provided at phase conductor only.

**Cable Colour:**

All cables used must have colour as stated below:

**Two wire single phase A.C. system:**

Red, Yellow or Blue for phase.  
Black for neutral.  
Green or Green-Yellow for Earth.

**Three or four wire three phase A.C. system:**

Red for first phase. Yellow  
for second phase. Blue for  
third phase.  
Black for neutral.  
Green or Green-Yellow for earth

**Two wire D.C. system:**

Red for positive or switch wire. Black  
for negative.

**For two wire final sub circuits.**

Whether A.C. or D.C. supplying lighting or power circuits, the neutral or 'middle' wire shall always be black and the phase or outer wire (no matter which phase it is connected to) shall always be red. For lighting, the red wire shall always feed the switch, and the red wire shall always be used from the switch to the light.

**Cable Identification:**

All cables, all feeders or circuits in all distribution boards shall be provided with permanent and approved type of identification.

**7.3.3 Earth Continuity Conductor (ECC)****7.3.3.1 Earth Continuity****Conductor Material**

All ECC shall be insulated copper (BYA cable) as indicated in the schedule of items and bill of quantities. ECC shall be of white/green/green-yellow colored.

**Installation**

The earth continuity conductor and earthing lead shall run in accordance with the drawings and direction, and all metal fittings shall be earthed with continuity conductors. All the earth continuity conductors from various circuits, sockets, etc. shall be connected to the earthing block located within the MDB/SDB. Size of earth continuity conductors shall be as stated in the drawings. The earth continuity conductor shall be drawn along with the cables as per drawing and to the satisfaction of Project Manager and no joint shall be allowed from earthing block to the respective earth point. Light and fan points, except where indicated otherwise shall not be earthed.

**7.3.3.2 Light Fitting Material:**

The light fitting shall be manufactured as per design, specification and schedule of items and BOQ and shall comply with the relevant requirements of standards, including BS 4533.

The chokes, if applicable, shall comply with the requirements of BS 2818, and shall have appropriate power factor correction capacitor (250V, 3.5  $\mu$ F for 20W and 40W tubes), the improved P.F shall not be less than 0.90. In no case power consumption by the choke shall be more than 16W for magnify ballast.

The starters shall be 2 W-I amp type and shall have built-in radio interference suppressor capacitor.

All incandescent light fittings, except where specifically stated otherwise, shall have un switched brass holders, lamp caps, complying with BS 52.

Type of lamp and detail technical data of various categories of lamps shown in design and schedule shall be followed. Appropriate sample of light fitting with choke starter and any relevant control gear shall be submitted for approval, prior to installation.

The bidder must submit detailed technical specification supported by catalogue for all light fittings, lamps, and accessories. The country of origin or manufacturer's country, brand name, model number etc. details are also to be furnished with the bid.



Any special feature, or equipment or control gear, such as photocell switch, time switch, power supply support battery, frame for installation of lamp and fixture, remote control wiring and equipment, relay etc required for any lamp, shall be inclusive of the respective light fitting item. No extra charge claimed for any of such feature or support. The entire work shall be carried out as per design, standard, schedule of works and to the satisfaction of the Project Manager.

### **Installation:**

The light fittings shall be installed in accordance with the applicable lighting layout drawings, and to the satisfaction of Project Manager.

All pendant fittings shall be supported from brass ceiling base plate with at least 100mm screw-hub.

The location of outlets shown in the design shall be considered as approximate and it shall be the responsibility of the Contractor, before installation of outlet boxes, to study all related drawings and obtain precise information from the architectural drawing and schedule. Outlets incorrectly located and lights improperly installed, or any mal-function of any lamp shall be properly relocated or replaced by the Contractor at the Contractor's expense.

### **7.3.4 Lamp**

#### **Post Material:**

The G.I. pipe for lamp post shall be hot dip galvanized. The thickness of the pipe shall be as below:

| Normal pipe size (mm) | Wall thickness (mm) |
|-----------------------|---------------------|
| 25                    | 2.65                |
| 30                    | 2.65                |
| 38                    | 2.90                |
| 50                    | 2.90                |
| 63                    | 3.25                |
| 75                    | 3.25                |
| 100                   | 3.65                |
| 150                   | 4.85                |
|                       |                     |

---

**Installation**

Fabrication, installation, testing and commissioning shall be done as per drawing, schedule and to the satisfaction of the Project Manager.

**7.3.5 Ceiling****Fan Material:**

Ceiling fans shall be of capacitor type, AC 240V single phase, 50Hz, complete with suspension rod of required length, canopy and shall be constructed in accordance with applicable B.S. The minimum air velocity for 1400mm fan at horizontal distance of 600mm from the fan center and vertical distance of 1950mm shall be 47meter minute. Appropriate sample of fan shall be submitted prior to installation for approval.

**Installation:**

The fans shall normally be installed at a height of 2550 mm from the floor and in accordance with the applicable fan layout drawings and to the satisfaction of Project Manager. Circular box with ceiling rose for fan outlet shall be at the center of the clamps.

Fan incorrectly located or any mal-function of any fan shall be rectified or replaced by the Contractor at their own expense.

**7.4 Main Distribution Board& Sub-Distribution Board****(MDB/SDB) Material**

The MDB/SDB shall be as per design, specification mentioned in the schedule items and bill of quantities. Panels shall be designed for operation on a 240/415V, 50Hz, 3 phase, 4 wire system. The panels and bus bars shall have clearly marked identification.

The panels shall have printed directory on frames and on/inside of door. The door is to be provided with flush lock handle. All doors are to be keyed alike. All hinges shall be concealed. All bus bar shall be isolated by proper voltage rating insulators from board body, & front side of bus bar must have protective paints. Provision for cable entry to the DB shall be from top, bottom and sides.

The MCB/MCCB's shall be quick-make, quick-break type, and shall have inverse time limit characteristics with instantaneous magnetic trip elements functioning on overload, earth fault and short circuit. All circuit breakers shall be 'trip free'. Ratings and frame sizes of breakers shall be in accordance with design and schedule. Each breaker shall be capable of carrying rated full load current continuously without exceeding temperature rise specified in the applicable IEC standard. Circuit- breaker insulation shall be coordinated with the DB structure and shall be designed for use on 600-volt system. The MCB must comply with BS 3871 part I category M3 (5 A-60 A). Rated voltage 240/415V, A.C.50Hz, minimum interrupting capacity 6000 amp as per B.S. and capable of providing overload and short circuit protection, through thermal and magnetic trip actions



respectively. Temperature rating, of CB shall be 400 C, preferably tropicalised (moisture fungus corrosion treated), with contacts of silver alloy. The MCCB must comply with BS 3871; part 2. MCCB above 25 A TP shall be adjustable type.

The MCCB's shall have the minimum symmetrical interrupting capacity as per B.S. and IEC, at 415V A.C. if not indicated otherwise:

MCB up to 63A TP or SP shall have 6 KA rating. SDC (Switch Disconnecter) up to 125 A TP is 3 KA, up to 250 A TP is 4.3 KA.

The continuous current rating of individual MCB/MCCB's may be varied within + 15% at the time of installation without any additional cost implication.

### **Installation:**

The Board shall be installed in accordance with applicable layout drawing. Minimum height to bottom of the Board from the floor level shall be 600 mm and maximum height of any circuit breaker/switch shall be 1800 mm from the same level or as specified in the drawing. The minimum depth of MDB, DB or SDB etc. shall be in accordance with schedule of items and bill of quantity.

The location of MDB/SDB shown on design shall be considered as approximate and it shall be responsibility of the Contractor before installation of MDB/SDB to study all pertinent drawings and obtain precise information from the architectural drawings. MDB/SDB incorrectly located or any malfunction of any equipment, instrument in any board shall be properly relocated or replaced by the Contractor at the Contractor's expense.

Number of outgoing circuits in different panel boards may be varied by  $\pm 5\%$  at the time of installation.

## **7.5 Switch and Switch / Fan Regulator**

### **Board Material:**

Switch board and fan regulator board shall be as per design, specification and schedule and shall have gang switches MK England and fan regulators. The switches shall be vertical, single pole (1-way/2-way) 5A A.C., white or approved color, to BS 3676, complying with the test requirements for inductive, fluorescent or resistive loads as specified, and satisfy the test requirements of fluorescent lamp circuits, up to the ratings of these switches, as set out in BS 3676 amendment 3. The switches must have minimum clearance of 3mm between the contacts, and a similar distance. All contacts shall be faced with pure silver/silver-cadmium oxide alloy. The switch operating member shall make the speed of 'make and break' independent of the speed at which the switch is operated. Sample shall be submitted for approval prior to installation of switches.

Each board shall have copper earthing block/blocks of suitable size with necessary connecting arrangement.

**Installation:**

The switch board and fan regulator board shall be installed on wall at a height of 1.5 meter, if not specified otherwise, from the floor and at locations shown in applicable layout drawings. The fan regulators shall be installed inside the box with regulator knobs projected over the covering, if not specified otherwise. The phase wire shall be connected to the switches and the neutral wire shall be kept solid in all switch connections. The ECC shall be connected to the earth point inside the switch boards. Approved size steel boxes shall be installed at the time of construction of the wall to avoid chisell in wall.

The location of board shown on design shall be considered as approximate and it shall be responsibility of the Contractor, before installation switch board/regulator board boxes, to study all pertinent drawings and obtain precise information from the architectural drawings and approved shop drawings of other trades. Switch boards/regulator boards incorrectly located shall be properly relocated at the Contractor's expenses.

**7.6 Socket/MCB****Outlet Material**

Socket outlets shall be white in color, and conforming to B.S.546: (3 pins) and B.S. 372: part 1 (2 pins). All switched sockets shall have pure silver/silver-cadmium oxide alloy contacts in which contact pressure shall be permanently, maintained by subsidiary helical compression spring. These shall be supplied with countersunk cadmium plated fixing screws and mounted in 18 SWG (1.5 mm) hammer painted sheet steel box having brass earth point as per drawing and direction. All switch and socket outlets shall be international standard type and shall be of same manufacturer. The country of origin of switches and sockets shall be USA, UK, Germany, French or Japan/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer).

The Controlled sockets of MCB/MCCB, if applicable, shall be un switched and the box shall have earth point.

The lift indicator outlets shall be made of 16 SWG sheet steel, [stainless steel].

**Installation:**

The Socket/MCB/MCCB shall be installed on wall with lower end of the face plate at a height of 225mm (Skirting level) from the floor, if not specified otherwise, and locations shown in applicable design.

The fixing of the outlets boxes shall be by means of flat head cadmium plated screws. The flat head of the screw shall be sunk in the plates so as to finish flush with the surface of the cover. The mounting height of the outlet shall be as shown in the drawing. The earth wire shall be connected to earth point of the box to the 3rd pole of the 3-pin socket.

## **7.7 Earthing**

### **g Material:**

#### **Earthing Electrode:**

##### **a. Pipe Electrode**

This would be 40mm dia. G.I. pipe with two 3mm dia. holes across the diameter at every 1200mm at the pipe.

##### **b. Plate Electrode**

This earth electrode shall be cold rolled double copper plate 600mmx 600mmx3mm having provision for connecting the earthing lead.

#### **Earthing Lead:**

Earthing lead shall consist of copper conductor as per specification given in 23. All terminal lugs shall be of copper and nut bolts of brass.

#### **Earth Inspection Pit**

The size of earth inspection pit shall be constructed as per drawings. The Pit cover shall be constructed by RCC slab with 10mm dia. MS rod. & having two holding hook of 20mm dia. MS rod. The designed drawing shall be submitted for the Project Manager's approval.

### **Installation:**

#### **Earth electrode:**

##### **a. Pipe Electrode:**

The pipe earth electrode shall be buried below ground level, as per design and schedule by tube-well sinking method. The terminal connected to the earth electrode shall use a brass clamp. After making the connection, the clamp shall be covered with bitumen poured hot and covered with jute cloth.

##### **b. Plate Electrode:**

The plate earth electrode shall be buried below ground level as per schedule and installed in an upright position, completely surrounded by a bed of at least 300mm of charcoal and packed hard. Distance between any two-earth electrodes shall be at least 8 meter.

**Earthing Lead:**

The earthing lead from the earth electrode shall be connected to the earth block in MBDB etc. A double run of specified copper conductor (preferably tinned) shall be brought out of earth electrode through GI pipe and connected to the earth block. All earthing leads shall follow the shortest and most direct route to earth electrode and sharp bends shall be avoided. The earthing lead shall be made mechanically strong and electrically continuous and of minimum resistance. There shall be no joint in earthing lead conductor, between terminals.

**Earth Inspection Pit**

The earth inspection pit shall be constructed as per design, schedule and to the satisfaction of the Project Manager. The slab shall have level surface and the pit shall have well formed regular sides. Water curing for the slab and the pit shall be done for a minimum of 7 days.

**Earth Loop Resistance test:**

The maximum earth loop resistance from any point in the installation, including earthing lead to the earth electrode shall not exceed the resistance specified in the relevant standard of earth test. The Contractor must ensure that the leads are efficiently bonded to all metal works of the building other than the current carrying parts. It shall be the responsibility of the Contractor to provide earth tester, all equipment and supports, required for testing and test the installation in presence of the Consultant or authorized representative of the Authority & submit the earth test report to the relevant Authority for approval.

**7.8 Service Illumination Levels**

The lighting system shall be designed in accordance with the relevant standards to achieve the following levels of luminance.

**Building Lighting**

The following minimum luminance levels shall be provided.

|                           |         |
|---------------------------|---------|
| Toilets                   | 100 lux |
| Control / switchgear room | 300 lux |
| Battery room              | 200 lux |
| Customer Service room     | 300 lux |
| Stores room               | 200 lux |

The illumination levels at control of instrument panels shall be measured in a vertical plane at the panel location.

**Emergency Lighting**

An emergency lighting system shall be installed to provide the following.

|                       |        |
|-----------------------|--------|
| Control / relay Room  | 50 lux |
| Customer Service room | 50 lux |
| Workshop              | 50 lux |

An emergency exit light shall be mounted above each exit/entrance.

## Switchyard Lighting

The following minimum service illumination levels shall be provided;

|                                        |        |
|----------------------------------------|--------|
| General switchyard lighting            | 20 lux |
| At control panels and marshaling boxes | 50 lux |

## 7.9 Power Outlets

Power Outlets shall be installed in accordance with the relevant standards and according to the following tables. The actual location shall be determined during the detailed design stage with the approval of the Project Manager.

Table 1 Switchyard (New and Rehabilitated Substations)

|     | Amp | Nos. |                  |
|-----|-----|------|------------------|
| 1 ø | 30  | 6    | General Area     |
| 3 ø | 100 | 2    | Transformer Area |

Table 2 Building for New 10 MVA Substations

|     | Amp | Nos. |
|-----|-----|------|
| 1 ø | 10  | 6    |
|     | 30  | 6    |
| 3 ø | 50  | 1    |

Table 3 Building for New 5 MVA Substations and Augmented Substations

|     | Amp | Nos. |
|-----|-----|------|
| 1 ø | 10  | 3    |
|     | 30  | 4    |
| 3 ø | 50  | 1    |

## 7.10 CCTV system

**Contractor shall install CCTV system with 06 IP cameras and necessary accessories required for fitting & fixing up to commissioning. CCTV must be in suitable for place. Contractor shall require prior for the selection of place for the installation of CCTV.**

## **C. MISCELLANEOUS**

### **8.0 DESKTOP/LAPTOP COMPUTERS & ACCESSORIES**

## TECHNICAL REQUIREMENT AND GUARANTEE SCHEDULE For Desktop/Laptop Computers & Accessories

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data)

| Technical Particular's                 | BREB Specification                                                                                                                                                                                 | Guaranteed Specification |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b><u>Desktop Computer (Brand)</u></b> |                                                                                                                                                                                                    |                          |
| Brand                                  | Internationally Reputed Brand                                                                                                                                                                      |                          |
| Model                                  | To be Mentioned by bidder                                                                                                                                                                          |                          |
| Country of Origin                      | USA/UK/JAPAN/ Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer)     |                          |
| Processor                              | Intel core i5 11 <sup>th</sup> Generation or Higher                                                                                                                                                |                          |
| Speed                                  | Minimum 2.9 GHz to 4.00GHz, 6 Cores) or Higher                                                                                                                                                     |                          |
| Cache                                  | Minimum 9MB or Higher                                                                                                                                                                              |                          |
| Chipset                                | Intel Express Chipset B400 Series or Equivalent or Higher                                                                                                                                          |                          |
| RAM                                    | Minimum 8GB 2666MHz DDR4L Memory, 2 DIMM slots or Higher.                                                                                                                                          |                          |
| HDD                                    | Minimum 1TB 7200 RPM SATA or Higher                                                                                                                                                                |                          |
| SSD                                    | Minimum 120GB or Higher                                                                                                                                                                            |                          |
| LAN Card                               | Integrated Gigabit LAN-On-Motherboard or Higher                                                                                                                                                    |                          |
| Expansion Slots                        | Minimum (2) PCIe x 1, PCIe x 16                                                                                                                                                                    |                          |
| Ports                                  | Minimum (2) USB 3.0, (4) USB 2.0, RJ-45, HDMI, VGA/Display                                                                                                                                         |                          |
| Wireless                               | Built-in Wireless 802.11/b/g/n (2.4 GHZ)                                                                                                                                                           |                          |
| Graphics (AGP)                         | Built-in                                                                                                                                                                                           |                          |
| Audio (Sound Card)                     | Built-in                                                                                                                                                                                           |                          |
| DVD-RW Drive                           | DVD+/-RW Drive                                                                                                                                                                                     |                          |
| Monitor                                | 18.5" LED Backlit Color, Same Brand                                                                                                                                                                |                          |
| Key-Board                              | USB enhanced, Same Brand                                                                                                                                                                           |                          |
| Mouse                                  | USB Optical Mouse, Same Brand                                                                                                                                                                      |                          |
| Power Supply                           | Minimum 240 W PSU (APFC Full Charge)                                                                                                                                                               |                          |
| OS Support                             | Windows 10 or User Friendly.                                                                                                                                                                       |                          |
| Software                               | Windows 10, Office & Other Software as per site requirements.                                                                                                                                      |                          |
| Power Strip                            | Brand: Reputed Brand<br>Port: Minimum 5 Port<br>Cable Length: 3 meter<br>Number of pin: Minimum 3<br>Others: Rated voltage: 220 V, Rated current: Minimum 10 A,<br>Individual switch, Single fuse. |                          |
| Antivirus                              | Brand: To be Mentioned By the Bidder<br>Internet Security Antivirus, license for 1 year                                                                                                            |                          |

|          |          |  |
|----------|----------|--|
| Warranty | 3 Years. |  |
|----------|----------|--|

| Technical Particular's                            | BREB Specification                                                                                                                                                                            | Guaranteed Specification |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b><u>Laptop (Note Book) Computer</u></b>         |                                                                                                                                                                                               |                          |
| Brand                                             | Internationally Reputed Brand                                                                                                                                                                 |                          |
| Model                                             | To be Mentioned by bidder                                                                                                                                                                     |                          |
| Country of Origin                                 | USA/UK/JAPAN/Other eligible countries may be accepted where equivalent quality (Please see the instruction, Page:6-3) can be demonstrated (Acceptance of equivalency will depend on Employer) |                          |
| Processor                                         | Intel Core i5 (11 <sup>th</sup> Generation) or Higher                                                                                                                                         |                          |
| Speed                                             | Minimum 1.6 GHz or Higher                                                                                                                                                                     |                          |
| Cache                                             | 12 MB L3 Cache.                                                                                                                                                                               |                          |
| RAM                                               | Min. 8GB DDR4, 2666 MHz or Higher                                                                                                                                                             |                          |
| Display                                           | Min. 14"HD LED                                                                                                                                                                                |                          |
| Graphics                                          | Intel HD Graphics                                                                                                                                                                             |                          |
| SSD                                               | Minimum 512 GB SSD or Higher                                                                                                                                                                  |                          |
| Sound System                                      | To be mentioned by the bidder                                                                                                                                                                 |                          |
| Keyboard                                          | Full-size 85 Keys US Keyboard.                                                                                                                                                                |                          |
| Mouse                                             | Integrated pointing device with touch pad.                                                                                                                                                    |                          |
| Wireless                                          | Integrated                                                                                                                                                                                    |                          |
| NIC                                               | In-built with 10/100/1000                                                                                                                                                                     |                          |
| Web cam                                           | Integrated                                                                                                                                                                                    |                          |
| Slots                                             | 1 Multi-Format Digital Media Card Reader for Secure Digital cards, Multimedia Cards.                                                                                                          |                          |
| Expansion Ports/Interface                         | Min. 3 USB 3.1, 1 HDMI, 1 Microphone/ Headphone combo, 1 RJ-45                                                                                                                                |                          |
| Battery                                           | Min. 6 Hours Back-up time, 3 Cell 41Whr.                                                                                                                                                      |                          |
| Antivirus                                         | Brand: To be Mentioned By Bidder<br>Internet Security Antivirus, license for 1 year                                                                                                           |                          |
| Power Supply                                      | Universal 100 – 240V AC Adaptor for worldwide usage.                                                                                                                                          |                          |
| Operating System                                  | Free Dos                                                                                                                                                                                      |                          |
| Carrying Case                                     | Including Original Carrying case                                                                                                                                                              |                          |
| Standard                                          | ISO, CE & FCC Class-B.                                                                                                                                                                        |                          |
| Warranty                                          | 3 Years.                                                                                                                                                                                      |                          |
| <b><u>UPS (Un-interruptible Power Supply)</u></b> |                                                                                                                                                                                               |                          |
| Brand                                             | Internationally/Nationally Reputed Brand                                                                                                                                                      |                          |
| Model                                             | To be Mentioned by bidder                                                                                                                                                                     |                          |
| Country of Origin                                 | To be Mentioned by bidder                                                                                                                                                                     |                          |
| Capacity                                          | Min.1000VA or Higher                                                                                                                                                                          |                          |
| Backup time                                       | Minimum 1 Hour for One CPU and Monitor.                                                                                                                                                       |                          |
| Input voltage range                               | Minimum 145-280VAC.                                                                                                                                                                           |                          |
| Frequency                                         | 50 Hz + 1%.                                                                                                                                                                                   |                          |



|                |                                                       |  |
|----------------|-------------------------------------------------------|--|
| Protection     | Fuse. Over load, discharge and overcharge protection. |  |
| Output voltage | 220V, 50Hz, + 10% AC                                  |  |
| Transfer time  | < 2 ms Typically.                                     |  |
| Battery type   | Lead acid Maintenance Free.                           |  |

| Technical Particular's                           | BREB Specification                                                                                                                                                                    | Guaranteed Specification |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Recharge time                                    | Min 8 hrs. to 90% after fully discharge.                                                                                                                                              |                          |
| Exhaust System                                   | Cooling fan on back                                                                                                                                                                   |                          |
| DC start up                                      | Yes.                                                                                                                                                                                  |                          |
| Protection                                       | Built-in Automatic voltage Regulator with lightning surge protection, Spike burnouts, over voltage & under Voltage cut- off, Battery low & over charge protection & Surge protection. |                          |
| Standard                                         | ISO 9001, CE for manufacture.                                                                                                                                                         |                          |
| Warranty                                         | 1 Year.                                                                                                                                                                               |                          |
| <b><u>Laser Printer (Medium Duty: Type-1</u></b> |                                                                                                                                                                                       |                          |
| Brand                                            | Internationally Reputed Brand                                                                                                                                                         |                          |
| Model                                            | To be Mentioned by bidder                                                                                                                                                             |                          |
| Country of Origin                                | To be Mentioned by bidder                                                                                                                                                             |                          |
| Processor Speed                                  | Min. 1200 MHz                                                                                                                                                                         |                          |
| Resolution                                       | 1200 X 1200 DPI                                                                                                                                                                       |                          |
| Printing Speed                                   | Min. 40 ppm for Letter                                                                                                                                                                |                          |
| Memory                                           | Min. 256 MB or Higher                                                                                                                                                                 |                          |
| Network Print                                    | Yes                                                                                                                                                                                   |                          |
| Duplex Print                                     | Yes (Automatic)                                                                                                                                                                       |                          |
| Control Panel                                    | 2 Line Backlit LCD Graphic display                                                                                                                                                    |                          |
| Fuser Unit                                       | Instant on fuser technology with ceramic heating elements.                                                                                                                            |                          |
| Printing Pages/Month                             | Min. 75,000 Pages                                                                                                                                                                     |                          |
| Interface                                        | 1 Hi Speed USB 2.0 Port; 1 Ethernet port 10/100/1000 Gigabit network                                                                                                                  |                          |
| Combability                                      | PCL6, PS 3 & PPDS                                                                                                                                                                     |                          |
| Paper Size                                       | A4 & Legal                                                                                                                                                                            |                          |
| Paper Drawer                                     | Up to 250 Sheet                                                                                                                                                                       |                          |
| Warranty                                         | 1 Year (Full).                                                                                                                                                                        |                          |

Note: In Support of offered Specification, Printed Catalog must be Submitted by bidder.

**Seal & Signature of the Manufacturer**

**Seal & Signature of the Bidder**

## C. MISCELLANEOUS

### **9.0 AIR CONDITIONER**

### TECHNICAL REQUIREMENTS FOR AIR CONDITIONER

(To be filled up by the Bidder/manufacturer in concern Letterhead Pad with appropriate data)

Eight Split Type air conditioners of capacity 2.5 Tons each shall be provided for each control room.  
Each unit shall conform to the following specifications:

| Technical Particular's            | BREB Specification                                                                                                                                                                                                    | Guaranteed Specification |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Brand                             | Internationally Reputed Brand                                                                                                                                                                                         |                          |
| Model                             | To be Mentioned by bidder                                                                                                                                                                                             |                          |
| Country of origin                 | To be Mentioned by bidder                                                                                                                                                                                             |                          |
| Cooling Capacity (BTU / HR) / Ton | 30000/2.5                                                                                                                                                                                                             |                          |
| Power Supply                      | 230V+/-5%, 50 HZ                                                                                                                                                                                                      |                          |
| Power Input (Watt)                | 2850W (Max.)                                                                                                                                                                                                          |                          |
| Current (Amp)                     | 13.0 A (Max.)                                                                                                                                                                                                         |                          |
| Indoor Air Circulation (CBM / H)  | 1380 (Min.)                                                                                                                                                                                                           |                          |
| Outdoor Air Circulation (CBM / H) | <b>4300 (Min.)</b>                                                                                                                                                                                                    |                          |
| Temperature Control               | Thermister                                                                                                                                                                                                            |                          |
| Auto Air Swing                    | 2-way to be provided                                                                                                                                                                                                  |                          |
| Minimum Noise Level Db(A)         | Indoor Unit: less than 45 db.<br>Outdoor Unit: less than 55 db.                                                                                                                                                       |                          |
| Remote                            | More than 10 meters remote control distance. Remote handset: LCD display with night glow.                                                                                                                             |                          |
| Installation                      | Bidder will complete the first time installation.                                                                                                                                                                     |                          |
| Refrigerant                       | Environment-Friendly                                                                                                                                                                                                  |                          |
| Type of Compressor                | High quality and approved brand with rotary type compressor                                                                                                                                                           |                          |
| Condenser Material                | Copper                                                                                                                                                                                                                |                          |
| Other                             | # Elegant panel design, with LED/LCD central Display.<br># Galvanized outdoor unit or plastic outdoor unit for anti-corrosion.<br># Flat panel for easy cleaning, washable plastic filter and horizontal auto louver. |                          |
| Warranty                          | One year replacement of all components free of cost and next two years Service free.                                                                                                                                  |                          |
| Supporting documents              | Must be supported by printed Catalogue/Manual.                                                                                                                                                                        |                          |

**Seal & Signature of the Manufacturer**

Single-Stage: Two-Envelope Construction of 33/11 GIS Substation on Turnkey Basis

**Seal & Signature of the Bidder**

Bidding Document for MCEP/BREB/ KD-W-10

## C. MISCELLANEOUS

### *10.0 CONTROL ROOM FURNITURE*

### TECHNICAL REQUIREMENTS FOR CONTROL ROOM FURNITURE

| Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Quantity<br>(Minimum but not limited to) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| <p><b>Table with Side Rack, TSR-2</b><br/> <b>Size: Table:</b> 1800×800×750H mm, <b>Side Rack:</b> 1050×400×750H mm</p> <p>Made of scratch proof pesticide treated MFC/Melamine coated liminated Board of Beech-graphite color. Table top of 30 mm and other panels are 18 mm thickness. Edges of panels and top are to be sealed by 2 mm PVC edging by Automatic edge bending machine. Top and panels should be joined by using housing, dowel, bolt, jibe screw, T.nut &amp; pneumatic nailing where necessary \. PVC stopper to be used at the bottom of Table. Knockdown facility with fixing manual is a mandatory with drawer unit and side rack.</p> | <p>1 Nos. for each sub-station</p>       |
| <p><b>Revolving Chair RC-1</b><br/> <b>Size:</b> 500×570×1140H mm</p> <p>Foam cushioning with foreign leather upholstery upon a contoured high back, tilt &amp; locking system. Chemically de-rusted, Zinc phosphate coated oven baked (150°-200°C). Electro-static powder paint finished mild steel structure. Gas lift system. Design as per photo image. Color of leather to be approved by the authority.</p>                                                                                                                                                                                                                                           | <p>1 Nos. for each sub-station</p>       |
| <p><b>Visiting Chair VC-1</b><br/> <b>Size:</b> 560×600×900H mm</p> <p>Made of Foam cushioning with foreign rexene upholstery. Arm with foam cushioning with leather. Structure made of cold rolled mild steel round tube which is chemically de-rusted with Zinc phosphate coated oven baked (150°-200°C). Electro-static powder paint finished. The tube structure should be V-shaped, cantilever type and the diameter for tube must be 1.25" &amp; with PVC stoppers. Design as per photo image. Color of rexene to be approved by the authority.</p>                                                                                                   | <p>4 Nos. for each sub-station</p>       |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| <b>File cabinet (3 Drawer) FC-1</b><br><b>Size:</b> 476×610×1069 mm.<br><br>Made of high-grade cold rolled steel sheet of .7mm (22 SWG) thickness reinforced with stiffeners equipped. High strength drawer channels, nylon drawer grip with three drawers high quality central locking system. All sheets chemically de-rusted, zinc phosphate coated with oven baked (150°-200°C), electrostatic paint finished. Design as per photo image. Color of cabinet to be approved by the authority. | 1 Nos. for each sub-station |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|

| Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Quantity<br>(Minimum but not limited to) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| <p><b>Computer Table CT-1</b><br/> <b>Size:</b> 620×530×1020H<br/> mm</p> <p>Made of scratchproof pesticide treated MFC/Melamine coated laminated Board of Beech color. Table top of 18 mm and other panels are of 16 mm thickness. strong PVC Edging done by Automatic bending machine. Sliding Key-board tray and drawer with locking system. Half shelf for UPS/Stabilizer. Top and panels should be joined by using housing, dowel, bolt, jibe screw, T.nut &amp; Pneumatic nailing where necessary. PVC stoppers &amp; knock down facility is mandatory. Provision for Monitor on the top, CPU inside the table and cable passing hole is necessary. Design as per photo image.</p> | <p>1 Nos. for each sub-station</p>       |

Note: In Support of offered Specification, Printed Catalog must be submitted by Bidder.





## C. MISCELLANEOUS

### 11.0 FIRE DETECTION & PROTECTION FACILITIES



## **FIRE DETECTION & PROTECTION FACILITIES**

### **11.1 Design Requirements**

All fire protection installations shall comply with the requirements of the codes of practice of the National Fire Protection Association, Boston, Massachusetts, U.S.A. as appropriate for the respective systems, subject to the approval of the Project Manager. The Codes and practice of the Japanese Fire Protection may also be considered.

### **11.2 Fire Detection and Alarm system**

Fire detection shall be by means of smoke detectors/heat detectors with a backup system utilizing rate-of-rise temperature detectors along with alarm system. The system and its components must conform to the applicable appropriate standards. The use of these detectors shall be subject to specific approval by the Project Manager as regards their type and location.

#### **(a) Fire Alarm Panel: 16 Zone Capacity:**

Supply and Installation of 16 Zone Conventional Fire alarm control panel with power supply unit, batteries and other accessories. The panel shall be complete with zone indicating LED, Fault Indication and optional telephone Jack etc. The pane shall be input 220V AC and output 24V DC. Panel shall be confirmed UL Listed or EN54.

Country of Origin: Japan / Italy / UK / USA or equivalent approved by the Project Manager.

#### **(b) Fire Alarm Bell:**

Supply and installation of Conventional type Fire Alarm Bell of 150mm dia, red color, shall be UL / ULC / CSFM / FM / MEA / BFP / EN54 approved. Power supply shall be 24VDC. Sound level shall be not less than 92 dBA @ 3meter. Color of the Bell shall be red.

Country of Origin: Japan / Italy / UK / USA or equivalent approved by the Project Manager.

#### **(c) Optical / Photoelectric Smoke Detector:**

Supply and installation of Smoke Detector complete with base. Shall be UL / ULC / CSFM / FM / MEA / BFP / EN54 approved. Integrated alarm LED. Remote LED connection. Power supply shall be 24VDC.

Country of Origin: Japan / Italy / UK / USA or equivalent approved by the Project Manager.

(d) Heat Detector:

Supply and installation of Heat Detector complete with base. Shall be UL / ULC / CSFM / FM / MEA / BFP / EN54 approved. Integrated alarm LED. Remote LED connection. Power supply shall be 24VDC.

Country of Origin: Japan / Italy / UK / USA or equivalent approved by the Project Manager.

### **11.3 Fire Extinguisher**

(a) Dry Chemical Powder Type:

Supply & fixing the multipurpose ABCE dry chemical powder stored pressure type with manometer system. Fire Extinguisher suitable for repeated use complete with wall bracket, discharge valve, hose pipe, easy refilling system etc. as per sample approved by the Project Manager.

Country of Origin: China / Malaysia or equivalent approved by the Project Manager.

Quantity: Trolley mounted one (1) 15 kg , Two(2) 2kg, Two (2) portable 2 kg and wall mounted two (2) 5kg dry powder fire extinguishers shall be located adjacent to each power transformers.

(b) Carbon-Di-Oxide Type:

Supply & fixing the Carbon-di-Oxide type Fire Extinguisher suitable for repeated use complete with wall bracket, manometer etc. as per sample approved by the Project Manager.

Country of Origin: China / Malaysia or equivalent approved by the Project Manager.

Quantity: Two (2) portable 5 kg stored pressure carbon dioxide types shall be located inside the control room.

### **11.4 Sand Buckets**

The Bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to NFPA Codes and Standard.

## **9. Appendix**

### **Gender action Plan**

[The Contractor shall comply with the requirement of Activity-5 of Gender action Plan].

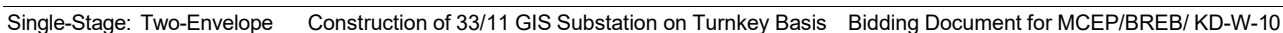
The target indicator under the Activity-5 of Gender action Plan are listed below. The Contractor shall comply to implement the below indicator during design stage & execution stage of the contract. The design must be approved by Employer and also execution of the said indicator shall be carried out by taking prior approval of the Employer.

- Separate and adequate quantity of toilets for men and women
- Separate prayer room where applicable
- Segregated resting area for women
- Ramps for physically challenged in the building construction

## 4. Drawings

### NOTE

*For a design, supply, and installation contract, no detail drawings would be available at the pre-bid stage. It would, however, be useful to include such conceptual drawings as are appropriate to supplement or help explain the general concept of the Employer's needs.*







## **5. Supplementary Information**

## **6. Certificates**

## 7.1 Form of Completion Certificate

Contract: [ insert name of contract and contract identification details]

Date: .....

Certificate No.: .....

To: [insert name and address of contractor]

Dear Ladies and/or Gentlemen,

Pursuant to GCC Clause 24 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated [insert date], relating to the [brief description of the Facilities], we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: [description]
2. Date of Completion: [date]

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

[Signature]

Project Manager

## 7.2 Form of Operational Acceptance Certificate

Contract: *[insert name of contract and contract identification details]*

Date: .....

Certificate No.: .....

To: *[insert name and address of contractor]*

Pursuant to GCC Subclause 25.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated *[date]*, relating to the *[brief description of the facilities]*, we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof: *[description]*
2. Date of Operational Acceptance: *[date]*

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

*[Signature]*

Project Manager

## **7. Change Orders**

### **8.1 Change Order Procedure**

- (a) General
- (b) Change Order Log
- (c) References for Changes

### **8.2 Change Order Forms**

- (a) Request for Change Proposal
- (b) Estimate for Change Proposal
- (c) Acceptance of Estimate
- (d) Change Proposal
- (e) Change Order
- (f) Pending Agreement Change Order
- (g) Application for Change Proposal

## **8.1 Change Order Procedure**

### **8.1.1 General**

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions.

### **8.1.2 Change Order Log**

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

### **8.1.3 References for Changes**

- (1) Request for Change as referred to in GCC Clause 39 shall be serially numbered CR-X-nnn.
- (2) Estimate for Change Proposal as referred to in GCC Clause 39 shall be serially numbered CN-X-nnn.
- (3) Acceptance of Estimate as referred to in GCC Clause 39 shall be serially numbered CA-X-nnn.
- (4) Change Proposal as referred to in GCC Clause 39 shall be serially numbered CP-X-nnn.
- (5) Change Order as referred to in GCC Clause 39 shall be serially numbered CO-X-nnn. Note:
  - (a) Requests for Change issued from the Employer's Home Office and the Site representatives of the Employer shall have the following respective references:

|             |          |
|-------------|----------|
| Home Office | CR-H-nnn |
| Site        | CR-S-nnn |
  - (b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal, and Change Order.

## 8.2 Change Order Forms

### 8.2.1 Request for Change Proposal Form

[Employer's letterhead]

To: [Contractor's name and address]

Date: .....

Attention: [Name and title]

Contract Name: [Contract name]

Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within [number] days of the date of this letter [or on or before (date)].

1. Title of Change: [Title]
2. Change Request No./Rev.: [Number]
3. Originator of Change:  
Employer: [Name]  
Contractor: (by Application for Change Proposal No. [Number Refer to Annex 6.2.7])
4. Brief Description of Change: [Description]
5. Facilities and/or Item No. of equipment related to the requested Change: [Description]
6. Reference drawings and/or technical documents for the request of Change: [Drawing No./Document No./Description]
7. Detailed conditions or special requirements on the requested Change: [Description]
8. General Terms and Conditions:
  - (a) Please submit your estimate showing what effect the requested Change will have on the Contract Price.
  - (b) Your estimate shall include your claim for the additional time, if any, for completing the requested Change.
  - (c) If you have any opinion that is critical to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us in your proposal of revised provisions.
  - (d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.
  - (e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

[Employer's Name]

[Signature]

[Name of signatory]

[Title of signatory]

## 8.2.2 Estimate for Change Proposal Form

[Contractor's letterhead]

Date: .....

To: [Employer's name and address]

Attention: [Name and title]

Contract Name: [Contract name]

Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost to prepare the below-referenced Change Proposal in accordance with GCC Subclause 39.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Subclause 39.2.2, is required before estimating the cost for change work.

1. Title of Change: [Title]
2. Change Request No./Rev.: [Number]
3. Brief Description of Change: [Description]
4. Scheduled Impact of Change: [Description]
5. Cost for Preparation of Change Proposal: [insert costs, which shall be in the currencies of the contract]
  - (a) Engineering (Amount)

|                        |                                   |         |
|------------------------|-----------------------------------|---------|
| (i) Engineer           | _____ hours (hrs) x _____ rate/hr | = _____ |
| (ii) Draftsperson      | _____ hrs x _____ rate/hr         | = _____ |
| Subtotal               | _____ hrs                         | = _____ |
| Total Engineering Cost |                                   | = _____ |
  - (b) Other Cost = \_\_\_\_\_
| Total Cost (a) + (b) |  | = \_\_\_\_\_ |

[Contractor's name]

[Signature]

[Name of signatory]

[Title of signatory]



### 8.2.3 Acceptance of Estimate Form

[Employer's letterhead]

To: [Contractor's name and address]

Date: .....

Attention: [Name and title]

Contract Name: [Contract name]

Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change: [Title]
2. Change Request No./Rev.: [Request number/revision]
3. Estimate for Change Proposal No./Rev.: [Proposal number/revision]
4. Acceptance of Estimate No./Rev.: [Estimate number/revision]
5. Brief Description of Change: [Description]
6. Other Terms and Conditions: In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparing the Change Proposal described in your Estimate for Change Proposal mentioned in para. 3 above in accordance with GCC Clause 39 of the General Conditions.

[Employer's Name]

[Signature]

[Name of signatory]

[Title of signatory]

## 8.2.4 Change Proposal Form

[Contractor's letterhead]

To: [Employer's name and address]

Date:

Attention: [Name and title]

Contract Name: [Contract name] Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

In response to your Request for Change Proposal No. [Number], we hereby submit our proposal as follows:

1. Title of Change: [Name]
2. Change Proposal No./Rev.: [Proposal number/revision]
3. Originator of Change: Employer: [Name]/Contractor: [Name]
4. Brief Description of Change: [Description]
5. Reasons for Change: [Reason]
6. Facilities and/or Item No. of Equipment related to the requested Change: [Facilities]
7. Reference drawings and/or technical documents for the requested Change: [Drawing/Document No./Description]
8. Estimate of increase/decrease to the Contract Price resulting from the Change Proposal:

Amount

[insert amounts in the currencies of the Contract]

- |                                                   |       |
|---------------------------------------------------|-------|
| (a) Direct material                               | ..... |
| (b) Major construction equipment                  | ..... |
| (c) Direct field labor (Total hrs)                | ..... |
| (d) Subcontracts                                  | ..... |
| (e) Indirect material and labor                   | ..... |
| (f) Site supervision                              | ..... |
| (g) Head office technical staff salaries          |       |
| Process engineer      _____ hrs @ _____ rate/hr   | ..... |
| Project engineer      _____ hrs @ _____ rate/hr   | ..... |
| Equipment engineer      _____ hrs @ _____ rate/hr | ..... |
| Procurement      _____ hrs @ _____ rate/hr        | ..... |
| Draftsperson      _____ hrs @ _____ rate/hr       | ..... |
| Total      _____ hrs                              |       |
| (h) Extraordinary costs (computer, travel, etc.)  | ..... |
| (i) Fee for general administration, % of Items    | ..... |
| (j) Taxes and customs duties                      | ..... |

Total lump sum cost of Change Proposal [Sum of items (a) to (j)]

Cost to prepare Estimate for Change Proposal [Amount payable if Change is not accepted]

9. Additional time for Completion required due to Change Proposal
10. Effect on the Functional Guarantees
11. Effect on the other terms and conditions of the Contract

12. Validity of this Proposal: within [Number] days after receipt of this Proposal by the Employer

13. Other terms and conditions of this Change Proposal:

- (a) You are requested to notify us of your acceptance, comments, or rejection of this detailed Change Proposal within *[Number]* days from your receipt of this Proposal.
- (b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.
- (c) Contractor's cost for preparation of this Change Proposal: *[insert amount. This cost shall be reimbursed by the employer in case of employer's withdrawal or rejection of this Change Proposal without default of the contractor in accordance with GCC Clause 39 of the General Conditions.]*

*[Contractor's name]*

*[Signature]*

*[Name of signatory]*

*[Title of signatory]*

## 8.2.5 Change Order Form

[Employer's letterhead]

To: [Contractor's name and address]

Date:

Attention: [Name and title]

Contract Name: [Contract name] Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

We approve the Change Order for the work specified in the Change Proposal (No. [number]), and agree to adjust the Contract Price, Time for Completion, and/or other conditions of the Contract in accordance with GCC Clause 39 of the General Conditions.

1. Title of Change: [Name]
2. Change Request No./Rev.: [Request number/revision]
3. Change Order No./Rev.: [Order number/revision]
4. Originator of Change: Employer: [Name]/Contractor: [Name]
5. Authorized Price:                      Ref. No.: [Number] Date: [Date]  
Foreign currency portion [Amount] plus Local currency portion [Amount]
6. Adjustment of Time for Completion:  
None                      Increase [Number] days                      Decrease [Number] days
7. Other effects, if any:

Authorized by: \_\_\_\_\_ Date: \_\_\_\_\_  
Employer

Accepted by: \_\_\_\_\_ Date: \_\_\_\_\_  
Contractor

## **8.2.6 Pending Agreement Change Order Form**

*[Employer's letterhead]*

To: *[Contractor's name and address]*

Date:

Attention: *[Name and title]*

Contract Name: *[Contract name]*

Contract Number: *[Contract number]*

Dear Ladies and/or Gentlemen:

We instruct you to carry out the work in the Change Order detailed below in accordance with GCC Clause 39 of the General Conditions.

1. Title of Change: *[Name]*
2. Employer's Request for Change Proposal No./Rev.: *[number/revision]* Dated *[Date]*
3. Contractor's Change Proposal No./Rev.: *[number/revision]* Dated *[Date]*
4. Brief Description of Change: *[Description]*
5. Facilities and/or Item No. of equipment related to the requested Change: *[Facilities]*
6. Reference Drawings and/or technical documents for the requested Change:  
*[Drawing/Document No./Description]*
7. Adjustment of Time for Completion:
8. Other change in the Contract terms:
9. Other terms and conditions:

*[Employer's name]*

*[Signature]*

*[Name of signatory]*

*[Title of signatory]*

## 8.2.7 Application for Change Proposal Form

[Contractor's letterhead]

To: [Employer's name and address]

Date:

Attention: [Name and title]

Contract Name: [Contract name]

Contract Number: [Contract number]

Dear Ladies and/or Gentlemen:

We hereby propose that the work mentioned below be treated as a Change in the Facilities.

1. Title of Change: [Name]
2. Application for Change Proposal No./Rev.: [Number / revision]      Dated [Date]
3. Brief Description of Change: [Description]
4. Reasons for Change:
5. Order of Magnitude Estimation (amount in the currencies of the Contract): [Amount]
6. Scheduled Impact of Change:
7. Effect on Functional Guarantees, if any:
8. Appendix:

[Contractor's name]

[Signature]

[Name of signatory]

[Title of signatory]

## 8. Personnel Requirements

Using Form PER – 1 and PER – 2 in Section 4 (Bidding Forms), the Bidder must demonstrate that it has personnel who meet the following requirements. The list of key personnel should be consistent with Section 3 (Evaluation and Qualification Criteria):

| No.                    | Position                               | General Qualifications | Total Work Experience (years) | Experience in Similar Work (years) |
|------------------------|----------------------------------------|------------------------|-------------------------------|------------------------------------|
| Design Personnel       |                                        |                        |                               |                                    |
| 1                      | Project Manager 01 Nos                 | Bsc In EEE/ME          | 15                            | 10                                 |
| 2                      | Electrical Design Engineer- 02 Nos     | Bsc In EEE/ME          | 10                            | 5                                  |
| 3                      | Testing & Commissioning Engineer-01 No | Bsc In EEE             | 10                            | 5                                  |
| 4                      | Technicia 02 Nos                       | Diploma Engineer       | 6                             | 4                                  |
| [Others]               |                                        |                        |                               |                                    |
| Construction Personnel |                                        |                        |                               |                                    |
| 1                      | Site Engineer- 05 Nos                  | Bsc In EEE             | 10                            | 5                                  |
| 2                      | Construction Supervisor -05            | Diploma Engineer       | 10                            | 7                                  |
| [Others]               |                                        |                        |                               |                                    |

### NOTE

*The managerial and technical competence of a Contractor is largely related to key personnel on site. The extent to which the Bidder should demonstrate having staff with extensive experience should be limited to those requiring critical operational or technical skills. The personnel requirement should, therefore, refer to a limited number of such key personnel, for instance, the project or contract manager and those superintendents working under the project manager who will be responsible for major components (e.g., superintendents specialized in dredging, piling, tunneling, or earthworks, as required for each particular project).*

*Requirements should specify*

- (i) *the general qualifications required for the position (education, professional license holder, and others), including the number of years of key experts with the Employer for a certain position only;*
- (ii) *the number of years of total work experience; and*
- (iii) *the number of years of relevant experience in similar work, comparable projects, sector, and/or services.*

*It is appropriate to specify that certain positions are filled by individuals who have held posts of comparable authority for, say, 3 years with the Bidder, so that key staff in executive site positions have sufficient knowledge of the Bidder's management, policy, procedures, and practices to act with confidence and authority within that framework.*

The Bidder must demonstrate that it has EHS personnel who meet the following requirements:  
Key Personnel as Determined by the Environmental, Health, and Safety Management Plan and Other EHS Assessment and Management Documents

| No. | Position/ Specialization | Relevant Academic Qualifications | Minimum Years of Relevant Work Experience | Minimum Time On-Site (% FTE) |
|-----|--------------------------|----------------------------------|-------------------------------------------|------------------------------|
|-----|--------------------------|----------------------------------|-------------------------------------------|------------------------------|

**NOTE**

*Insert in the above table, the minimum key EHS specialists required to execute the contract, taking into account the nature, scope, complexity, and risks of the contract. Inclusion of dedicated EHS personnel shall be based on EHS risk assessed and complexity of works. In some cases, it may not be necessary to allocate point of contact for each area of expertise, instead one personnel may support EHS related activities. For smaller contracts, instead of dedicated personnel, the Employer may allow the Contractor to assign the responsibility to existing personnel with clear identification of such personnel to all concerned parties.*

|   |                          |                                                        |   |     |
|---|--------------------------|--------------------------------------------------------|---|-----|
| 1 | Environmental specialist | Bsc in Environmental Science/ Environmental Management | 5 | 25% |
| 2 | Social specialist        | Bechelor Degree in related dicipline                   | 5 | 25% |
| 3 | H&S officer              | Bechelor Degree in related dicipline                   | 5 | 25% |
| 4 | Labor/HR specialist      | Bechelor Degree in related dicipline                   | 5 | 25% |

FTE = full-time employee.



## 9. Equipment Requirements

Using Form EQU in Section 4 (Bidding Forms), the Bidder must demonstrate that it has the key equipment listed below:

| No. | Equipment Type and Characteristics                                                                                      | Minimum Number Required |
|-----|-------------------------------------------------------------------------------------------------------------------------|-------------------------|
| 1   | Mobile Crane with Adequate capacity for lifting and placement of heavy goods like power transformer or other Equipments | As required             |
| 2   | Fork Lift 2 ton                                                                                                         | As required             |
| 3   | Dump Truck                                                                                                              | As required             |
| 4   | Concrete Mixture Machine                                                                                                | As required             |
| 5   | Piling Equipments                                                                                                       | As required             |
| 6   | Testing Equipments                                                                                                      | As required             |
|     |                                                                                                                         |                         |

### NOTE

*The Employer should only specify bulky or specialized items that are critical for the type of project to be implemented, and which may be difficult for the contractor to obtain quickly. Examples may include items such as heavy lift cranes and piling barges.*

*An inventory of construction equipment represents a high capital cost overhead to a contractor. Consequently, not all competent potential Bidders will maintain an inventory of high-value items that are in suitable condition for major contracts. This is particularly so with management contractors, who undertake construction projects mainly by subcontracting. In most cases, Bidders can readily purchase, lease, or hire equipment; Examples may include items such as heavy lift cranes and piling barges, etc. Even in such cases, contractors may not own the specialized items of equipment, and may rely on Specialist Subcontractors or equipment-hire firms. The availability of such Subcontractors and of the specified equipment should be subject to verification prior to contract award. The terms of any lease or hire agreement for equipment should preferably include a provision that the equipment will remain on the site (or be vested in the Employer) in the event of default of the contractor, thereby ensuring more timely continuity of work by a replacement contractor.*

## 10. Contract Management Plan

### NOTE

*The Employer shall prepare a suitable template for the Contractor's monthly progress report, also referred to as the Contract Management Plan, in line with the items listed in Sub-Clause 4.20 [Progress Reports] and in Part A of the Particular Conditions [Metrics for Progress Reports on Environment, Health, and Safety (EHS)]. The template should be included hereinafter and completed at the time the contract is signed. The template may be created using the Project Management Dashboard (PMD) platform ([www.pmdportal.com](http://www.pmdportal.com)) and attached to bidding document.*

The Contractor shall prepare the monthly progress report as per the format defined hereinafter, also referred to as the Contract Management Plan, in line with the requirements stipulated in Sub-Clause 18.3 [Progress Reports] and in Part A of the Particular Conditions [Environmental, Health, and Safety (EHS), Metrics for Progress Reports].