<table>
<thead>
<tr>
<th></th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chapter 1: Project Specification Requirement</td>
</tr>
<tr>
<td>2</td>
<td>Chapter 2: General Technical Requirement</td>
</tr>
<tr>
<td>3</td>
<td>Chapter 3: Switchgear</td>
</tr>
<tr>
<td>4</td>
<td>Chapter 4: LT Switchgear</td>
</tr>
<tr>
<td>5</td>
<td>Chapter 5: Battery &amp; Battery Charger</td>
</tr>
<tr>
<td>6</td>
<td>Chapter 6: Lighting System</td>
</tr>
<tr>
<td>7</td>
<td>Chapter 7: LT Transformer</td>
</tr>
<tr>
<td>8</td>
<td>Chapter 8: Fire Protection System</td>
</tr>
<tr>
<td>9</td>
<td>Chapter 9: Power &amp; Control Cable</td>
</tr>
<tr>
<td>10</td>
<td>Chapter 10: Air Conditioning System</td>
</tr>
<tr>
<td>11</td>
<td>Chapter 11: DG Set</td>
</tr>
<tr>
<td>12</td>
<td>Chapter 12: Switchyard Erection</td>
</tr>
<tr>
<td>13</td>
<td>Chapter 13: Structure</td>
</tr>
<tr>
<td>14</td>
<td>Chapter 14: Civil Works</td>
</tr>
</tbody>
</table>
CHAPTER 1 – PROJECT SPECIFICATION REQUIREMENT (PSR)
## CONTENTS

<table>
<thead>
<tr>
<th>CLAUSE NO.</th>
<th>PARTICULARS</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL</td>
<td>2</td>
</tr>
<tr>
<td>2.0</td>
<td>SCOPE</td>
<td>2</td>
</tr>
<tr>
<td>3.0</td>
<td>SPECIFIC EXCLUSIONS</td>
<td>13</td>
</tr>
<tr>
<td>4.0</td>
<td>PHYSICAL AND OTHER PARAMETERS</td>
<td>13</td>
</tr>
<tr>
<td>5.0</td>
<td>SCHEDULE OF QUANTITIES</td>
<td>14</td>
</tr>
<tr>
<td>6.0</td>
<td>BASIC REFERENCE DRAWINGS</td>
<td>14</td>
</tr>
<tr>
<td>7.0</td>
<td>ORDER OF PRECEDENCE OF DIFFERENT PARTS OF</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>TECHNICAL SPECIFICATION</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>SPARES</td>
<td>16</td>
</tr>
<tr>
<td>9.0</td>
<td>SPECIAL TOOLS AND TACKLES</td>
<td>17</td>
</tr>
<tr>
<td>10.0</td>
<td>FACILITIES TO BE PROVIDED BY THE OWNER</td>
<td>17</td>
</tr>
<tr>
<td>11.0</td>
<td>SPECIFIC REQUIREMENT</td>
<td>17</td>
</tr>
<tr>
<td>12.0</td>
<td>PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN &amp;</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>COMPLETION</td>
<td></td>
</tr>
</tbody>
</table>

## ANNEXURES

- ANNEXURE – I  LIST OF DRAWINGS
- ANNEXURE- II LIST OF PREFERED SHORTLISTED MAKE
- ANNEXURE- III AIR CONDITIONING SYSTEM FOR GIS PANEL ROOM
- ANNEXURE- IV SPECIFICATION OF PABX
- ANNEXURE- V EXISTING RTU BASED SCADA & ITS DATA ACQUISITION PRINCIPLE
- ANNEXURE– VI SPECIFICATION OF REVENUE/TARIFF ENERGMETER
- ANNEXURE– VII SPECIFICATION OF DIGITAL PROTECTION COUPLER
- ANNEXURE– VIII 33kV GIS TECHNICAL SPECIFICATION
- ANNEXURE– IX TECHNICAL PARAMETERS FOR 72.5 KV EQUIPMENTS & NEUTRAL CT
- ANNEXURE– X TECHNICAL SPECIFICATION FOR OIL FILTRATION PLANT
- ANNEXURE– XI TECHNICAL SPECIFICATION FOR LINE CURRENT DIFFERENTIAL RELAY
CHAPTER 1-Project Specification Requirement

1.0 GENERAL

1.1.1 The primary objective of Nepal Electricity Authority (NEA) is to generate, transmit and distribute adequate, reliable and affordable power by planning, constructing, operating and maintaining all generation, transmission and distribution facilities in Nepal's power system both interconnected and isolated.

1.1.2 Power Grid Corporation of India Ltd. (POWERGRID), A Govt. of India Enterprise has assisted in the tendering work as a Consultant for Udipur and New Bharatpur 220 kV GIS substation under the Marsyangdi Corridor 220 kV Transmission Line Project.

1.1.3 NEA is the Executive Agency SASEC Power System Expansion Project (SPEP). SPEP includes construction of (1) the 220kV Dana-Kushma-New Butwal, and 400kV New Butwal -Bardaghat transmission lines, and associated substations; (2) Manang-Khudi- Udipur- Markichowk-Bharatpur 220kV transmission line and associated substations; (3) Marsyangdi (Markichowk)- Matatirtha (Kathmandu) 220kV transmission line and associated substations; (4) Samundratar - Trishuli 3B hub 132kV transmission line and associated substation at Samundratar; (5) Grid substations reinforcement; (6) distribution systems in East, Central and West regions.

1.1.4 The ADB has appointed POWERGRID as Consultant for tendering of the SASEC Power System Expansion Project.

1.2 INTENT OF SPECIFICATION

This Substation portion of specification covers the execution of substation works along with Transformers for the subject package for establishing (i) New 220/132/33kV GIS (Gas Insulated Substation) type Substation at Udipur (ii) 220 kV (new) & Extension of 132 kV substations at Bharatpur. Above package also include (a) 4X53.33 MVA, 1-phase, 220/132/33kV Autotransformers at Udipur substation (b) 1X50 MVA, 132/33kV Transformer at Udipur substation and(c) 2X160 MVA, 3-phase, 220/132/33kV Autotransformer at Bharatpur substation. It is the intent of this specification to describe primary features, materials, and design & performance requirements and to establish minimum standards for the work. The specification is not intended to specify the complete details of various practices of manufactures/ bidders, but to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions. Bushing for voltage of 52 kV and above shall be Resin Impregnated Paper RIP bushing with composite polymer insulator shall be manufactured and tested as per latest IEC Standards.

2.0 SCOPE (for substation portion)

2.1 The broad scope of this specification covers the following substations along with associated transformers and other equipment.
2.1.1 Construction of a New 220/132/33 kV GIS (Gas Insulated Substation) type Substation at UDIPUR with the provision of following bays as per Single Line Diagram:

(A) 220 kV Switchyard: 220 kV switching scheme will be double main bus (DM) type. Details of bays are as below:

i. 220 kV line bays: 4(four) numbers for termination of Marsyangdi (Markichowk) double circuit lines & Khudi double circuit lines

ii. 220kV Transformer bay: 1 (one) number bay for bank of 3X53.33MVA, 220/132/33kV, 1-phase autotransformers bank.

iii. 220 kV Bus coupler bay: 1 (one) number and

iv. 220 kV auxiliary bus: 1 (one) number for connection of spare unit in place of any other unit of transformer bank

(B) 132 kV Switchyard: 132 kV switching scheme will be double main bus (DM) type. Details of bays are as below:

i. 132 kV line bays: 7(Seven) numbers.

ii. 132kV Transformer bay: two (one) number bay i.e. one for bank of 3X53.33MVA, 220/132/33kV, 1-phase auto-transformers bank and one for 1X50 MVA, 132/33 kV,3-phase transformer.

iii. 132kV Bus coupler bay: 1 (one) number and

iv. 132 kV auxiliary bus: 1 (one) number for connection of spare unit in place of any other unit of 220/132 kV transformer bank

(C) 33 kV Switchyard: 33 kV switching scheme will be Single bus (SM) type. Details of bays are as below:

i. 33 kV line bays: 6(Six) numbers.

ii. 33kV Transformer bay: 3 (Three) number bay i.e. two for 50 MVA, 132/33 kV 3-Phase Transformer (one Transformer under present scope & one for future Provision), one for 630kVA, 33/0.400kV, 3-Phase LT Transformer.

iii. 33kV Bus Sectioniser: One Bay

2.1.2 Construction of a new 220kV GIS substation & Extension of 132 kV substation at Bharatpur 132 kV Substation with the provision of following bays as per Single Line Diagram:

220 kV Switchyard: 220 kV switching scheme will be double main bus (DM) type. Details of bays are as below:

i. 220 kV line bays: 10 (ten) numbers of line bays. 2 bays each for 220 kV Double circuit New-Bharatpur- Marsyangdi (Markichowk), New-
Bharatpur-Damauli, Bharatpur-New Butwal, Bharatpur-Hetauda lines and 2(two) bays for future lines

ii. 220kV Transformer bay: 2 (Two) number of bays for Transformers i.e. 2 (Two) for 160 MVA, 220/132/33kV, 3-phase autotransformer.

iii. 220 kV Bus coupler bay: 1 (one) number

132 kV Existing Switchyard: 132 kV switching switchyard scheme will be double main bus (DM) type with bypass arrangement. Details of bays are as below:

i. 132kV Transformer bay: 2 (Two) number bay for Transformers i.e. 2(two) for 160 MVA, 220/132/33kV, 3-phase autotransformer to be supplied under subject package.

For connections of 132 kV side of transformers, 132 kV class EHV, XLPE Cu-cables (along with cable terminations at both end) of suitable rating is to be used.

2.2.0 The detailed scope of work is brought out in subsequent clauses of this chapter.

2.2.1 Construction of a New 220/132/33 kV GIS (Gas Insulated Substation) type Substation at UDIPUR.

2.2.1.1 Design, engineering, manufacture, testing, supply including transportation & insurance, storage, erection, testing and commissioning of following equipment and items complete in all respect:

2.2.1.1.1 245kV Gas Insulated Switchgear

245 kV SF6 gas insulated switch gear shall have double main bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF₆ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with necessary base plate & foundation bolts.

The SF6 gas insulated switch gear (50 Hz) shall be of the indoor metal- enclosed type, comprising of following modules:-

a) Three/Single isolated phase, 4000A, 40kA for 1 second, SF₆ gas-insulated metal enclosed bus bar of 245kV along with bus PT, each set comprising of the following:-

(i) Three (3) individual 1-phase/ one (1) 3-phase bus bars enclosures running the length of the switchgear to interconnect each of the circuit breaker bay modules in Double Bus bar system.

(ii) One (1) number 3-phase, 1600A, group operated isolator switches, complete with manual and motor driven operating mechanisms.
(iii) One (1) number 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(iv) Three (3) numbers 1-phase Potential Transformers with motorized isolating link.

(v) Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.

(vi) End Piece module with the test link for Future extension of Bus bar module at one end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. In case, 245kV Main Bus bar is offered with 3-ph enclosure, extension piece module shall include Adapter module to convert it to three individual 1-ph bus bar enclosures and same shall be deemed to be included in 245kV Bus Bar module.

(vii) Local control cubicle, if required separately.

b) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:-

i. One (1) number 3-phase, 1600A, SF₆ insulated circuit breaker without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 1600A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

iii. Two (2) numbers 3-phase, 1600A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Three nos. 1-phase, 1600A, 40kA individual pole operated isolator switches complete with manual and motor driven operating mechanisms.

vi. Three nos. 1-phases, 1600A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

vii. Three nos.1-phase, 1600A, 40 kA, individual pole operated , isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through 220kV Auxiliary bus . The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

viii. Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

ix. Local Control Cubicle.

c) 245 kV Auxiliary Bus to connect spare unit of Transformer.
i. One number 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall) for connection of spare unit with one ICT bay.

ii. One nos. 1-phases, 1600A, 40kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

iii. End Piece module with the test link for Future extension of Auxiliary Bus module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

iv. Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required

v. Local Bay control cubicle

d) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed Line bay module each set comprising of the following:-

(i) One (1) number 3-phase, 2400A SF₆ insulated circuit breaker without PIR complete with operating mechanism.

(ii) Three (3) numbers 1-phase, 2400A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

(iii) Three (3) numbers 3-phase, 2400A group operated isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Three (3) numbers 1-phase Potential Transformers with motorized isolating link.

(v) Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(vi) One (1) number 3-phase, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms.

(vii) Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

(viii) Local Control Cubicle.

e) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed Bus Coupler bay module each set comprising of the following:-

(i) One (1) number 3-phase, 4000A, SF₆ insulated circuit breaker without PIR complete with operating mechanism.

(ii) Three (3) numbers 1-phase, 4000A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

(iii) Two (2) numbers 3-phase, 4000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.
(iv) Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(v) Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

(vi) Local Control Cubicle.

The Switchgear shall be complete with all necessary terminal boxes, SF₆ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures. In addition all necessary platforms, supports, ladders and catwalks etc. for operation & maintenance work shall also be supplied.

f) **245kV Gas Insulated Bus (GIB) Ducts:**

245kV Gas Insulated Single phase enclosure Bus Duct (Including support structure, gas monitoring device, gas barrier, UHF PD Sensor etc.) from GIS building to Centre line of SF6/Air Bushing shall be as per BPS. Sf6 gas duct inside GIS building are part of respective GIS Module.

A tentative layout /GA drawing (drawing No. C/ENG/NEPAL/ Udipur GIS/Layout/001, Rev. 00) of the switchyard is enclosed with this specification for 220/132/33 kV Udipur Substation. The GIB duct length shall be optimized further without affecting the switchyard arrangement and required bay orientation and also any of the functional requirements specified.

g) **245kV Gas Insulated SF6 to Air Termination:**

(i) 245kV, 1600A/ 2400A (as per BPS), 1-phase SF₆ to air bushings for outdoor overhead connections. The cantilever strength of the 245kV SF₆ to air bushings shall be of minimum 8kN.

h) Testing and Maintenance Equipment as per BPS (Bid Price Schedule).

i) Mandatory Spares as per BPS (Bid Price Schedule).

j) Any other equipment/material required to complete the specified GIS scope of work.

2.2.1.1.2 **145kV Gas Insulated Switchgear**

145 kV SF6 gas insulated switch gear shall have double main bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF₆ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with necessary base plate & foundation bolts.
The SF6 gas insulated switch gear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

a) Three/Single isolated phase, 2000A, 31.5kA for 1 second, SF6 gas-insulated metal enclosed bus bar of 145kV along with bus PT, each set comprising of the following:

(i) Three (3) individual 1-phase/ one (1) 3-phase bus bars enclosures running the length of the switchgear to interconnect each of the circuit breaker bay modules in Double Bus bar system.

b) One (1) number 3-phase, 1600A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

(ii) One (1) number 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(iii) Three (3) numbers 1-phase Potential Transformers with motorized isolating link.

(iv) Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.

(v) End Piece module with the test link for Future extension of Bus bar module at one end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. In case, 145kV Main Bus bar is offered with 3-ph enclosure, extension piece module shall include Adapter module to convert it to three individual 1-ph bus bar enclosures and same shall be deemed to be included in 145kV Bus Bar module.

(vi) Local control cubicle, if required separately.

c) 145kV, 31.5kA for 1 second, SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:

(I) For bank of 220/132 /33 kV, 1-phase Auto-Transformer bay (with provision for connection with Spare 1-phase Auto-Transformer unit)

i. One (1) number 3-phase, 1200A, SF6 insulated circuit breaker without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 1200A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

iii. Two (2) numbers 3-phase, 1200A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
v. Three nos. 1-phase, 1200A, 31.5kA individual pole operated isolator switches complete with manual and motor driven operating mechanisms.

vi. Three nos. 1-phases, 1200A, 31.5kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

vii. Three nos. 1-phase, 1200A, 31.5kA, individual pole operated, isolator switches, complete with manual and motor driven operating mechanisms for switching of Spare ICT through 132kV Auxiliary bus. The isolator must meet the operational requirement in terms of insulation withstand requirement for connecting the same to auxiliary bus.

viii. Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

ix. Local Control Cubicle.

(II) For 132/33 kV, 3-phase Transformer bay

i. One (1) number 3-phase, A, SF6 insulated circuit breaker without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 800A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

iii. Three (3) numbers 3-phase, 800A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

v. Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

vi. Local Control Cubicle.

d) 145 kV Auxiliary Bus to connect spare unit of Transformer.

i. One number 1-phase (isolated) SF6 ducts inside GIS hall (up to outer edge of wall) for connection of spare unit with one ICT bays.

ii. One no. 1-phases, 1200A, 31.5kA individual operated safety grounding switches complete with manual and motor driven operating mechanisms.

iii. End Piece module with the test link for Future extension of Auxiliary Bus module at end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link.

iv. Gas monitoring devices, barriers, pressure switches, UHF based Partial Discharge measurement Sensors etc. as required.

v. Local Bay control cubicle
e) **145kV, 31.5kA** for 1 second, SF6 gas-insulated metal enclosed **Line bay module** each set comprising of the following:-

(i) One (1) number 3-phase, 800A, SF6 insulated circuit breaker without PIR complete with operating mechanism.

(ii) Three (3) numbers 1-phase, 800A, 6-core (4 for protection & 2 for metering), multi ratio, current transformers duly distributed on both side of circuit breaker.

(iii) Three (3) numbers 3-phase, 800A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Three (3) numbers 1-phase Potential Transformers (with four secondary i.e. 2 for protection & 2 for metering) with motorized isolating link.

(v) Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(vi) One (1) number 3-phase, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms.

(vii) Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

(viii) Local Control Cubicle.

f) **145kV, 31.5kA** for 1 second, SF6 gas-insulated metal enclosed **Bus Coupler bay module** each set comprising of the following:-

(i) One (1) number 3-phase, 2000A, SF6 insulated circuit breaker without PIR complete with operating mechanism.

(ii) Three (3) numbers 1-phase, 2000A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

(iii) Two (2) numbers 3-phase, 2000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(v) Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

(vi) Local Control Cubicle.

The Switchgear shall be complete with all necessary terminal boxes, SF₆ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures. In addition all necessary platforms, supports, ladders and catwalks etc. for operation & maintenance work shall also be supplied.
g) **145kV Gas Insulated Bus (GIB) Ducts:**

145kV Gas Insulated Single phase enclosure Bus Duct (Including support structure, gas monitoring device, gas barrier, UHF PD Sensor etc.) from GIS building to Centre line of SF6/Air Bushing shall be as per BPS. Sf6 gas duct inside GIS building are part of respective GIS Module.

A tentative layout /GA drawing (drawing. No. C/ENG/NEPAL/ Udipur GIS/Layout/001, Rev. 00) of the switchyard is enclosed with this specification for 220/132/33 kV Udipur Substation. The GIB duct length shall be optimized further without affecting the switchyard arrangement and bay orientation and also any of the functional requirements specified.

h) **145kV Gas Insulated SF6 to Air Termination:**

   (i) 145kV, 800A, 1-phase SF$_6$ to air bushings for outdoor overhead connections. The cantilever strength of the 145kV SF$_6$ to air bushings shall be of minimum 5kN.

i) Testing and Maintenance Equipment as per BPS (Bid Price Schedule).

j) Mandatory Spares as per BPS (Bid Price Schedule).

k) Any other equipment/material required to complete the specified GIS scope of work.

   During Engineering contractor is required to furnish the detailed document enlisting each and every GIS Module (indoor and outdoor) complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc. identifiable. The Purpose of above said document is to identify (as a part no.) each and every GIS Module individually in supplied GIS installation.

   The bidder shall note that the conductor terminating at Udipur SS is HTLS ACCC Drake. So substation scope shall incorporate the suitable/required equipment, hardware and accessories etc suitable for HTLS ACCC Drake conductor.

**33kV Gas Insulated Switchgear**

33kV SF6 gas insulated switch gear shall be 3-phase metal enclosed type and have single main bus bar arrangement with bus sectionaliser. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF$_6$ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment & piping and support structures along with necessary base plate & foundation bolts, as required. It shall be suitable for indoor installation and GIS switchboard structure must be made of standardized cubicles placed side by side, each consisting of modular buildup and standardized elements. Cubicles must be completely segregated one from other, containing the power parts of the cubicles.
Requirement of 36kV GIS shall be as per Technical specification enclosed as per Annexure-XI

The SF6 gas insulated switch gear (50 Hz) shall be of the indoor three phase metal-enclosed type, comprising of following modules:-

a) Three phase, 2500A, 31.5 kA for 1 second, SF$_6$ gas-insulated metal enclosed bus bar of 36kV along with bus PT, each set (for one section of bus) comprising of the following:-

(i) **bus bars** enclosures running the length of the switchgear to interconnect each of the circuit breaker bay modules in **Single bus system**

(ii) One (1) number 3-phase, 2500A, isolator switches, complete with manual and motor driven operating mechanisms.

(iii) One (1) number 3-phase, safety grounding switches, complete with manual and motor driven operating mechanisms.

(iv) One (1) number 3-phase Potential Transformers.

(v) Gas monitoring devices, barriers, pressure switches etc. as required.

(vi) Integrated Local Control Cubicle

b) Three phase 1250A, 31.5kA for 1 second, 36kV SF6 gas-insulated metal enclosed **Line bay module** each set comprising of the following:-

(i) One (1) number 3-phase, 1250A, SF$_6$ insulated/vacuum circuit breaker complete with operating mechanism.

(ii) One (1) number 3-phase, 1250A, 3-core, multi ratio, current transformers.

(iii) Two (2) numbers 3-phase, 1250A, isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Two (2) numbers 3-phase, group operated grounding switches, complete with manual and motor driven operating mechanisms.

(v) One (1) number 3-phase, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms

(vi) GIS cable termination enclosure with Isolating link, cable termination kit for making connection of 2x3Cx 400 sq. mm 33kV XLPE Cables

(vii) Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.
(viii) Local Control Cubicle.

c) Three phase **1250A, 31.5kA** for 1 second, **36kV** SF6 gas-insulated metal enclosed **Transformer bay module** each set comprising of the following:-

(i) One (1) number 3-phase, **1250A**, SF$_6$ insulated/vacuum circuit breaker complete with operating mechanism.

(ii) One (1) number 3-phase, **1250A**, 3-core, multi ratio, current transformers.

(iii) Two (2) numbers 3-phase, **1250A**, isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Three (3) numbers 3-phase, group operated grounding switches, complete with manual and motor driven operating mechanisms.

(i) Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.

(v) Local Control Cubicle.

d) Three phase **2500A, 31.5kA** for 1 second, **36kV** SF6 gas-insulated metal enclosed **Bus Section bay module** each set comprising of the following:-

(i) One (1) number 3-phase, **2500A**, SF$_6$ insulated/vacuum circuit breaker complete with operating mechanism.

(ii) One (1) number 3-phase, **2500A**, 3-core, multi ratio, current transformers.

(iii) Two (2) numbers 3-phase, **2500A**, isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Two (2) numbers 3-phase, grounding switches, complete with manual and motor driven operating mechanisms.

(v) Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.

(vi) Integrated Local Control Cubicle.

e) Any other equipment/material required to complete the specified GIS scope of work.

2.2.1.1.3 **Air insulated switchgear(AIS) and Other Main Equipment**

(a) 4 (Four) numbers of 53.33MVA, 220/132/33kV, 1-phase auto- transformers.

(b) 1(one) numbers of 50 MVA, 132/33kV, 3-phase Transformers
(c) 2 (two) number 630kVA, 33/0.400kV LT transformer along with associated equipment

(d) For 245kV, 145kV & 36 kV system Surge Arrestors and Bus Post Insulators, 72.5kV circuit breakers, isolators, earth switches, current transformers, capacitor voltage transformers, PT and surge arresters for tertiary loading as per BPS.

a) For 220/132/33kV GIS, Sub-station automation system including hardware and software for local as well as remote control station along with associated equipment for following bays (bay as defined in Technical Specification, Section - Substation Automation).

- **BCU FOR 245KV- 6 NUMBER BAYS, 132KV- 10 NUMBER BAYS, 36 KV- 9 BAYS & 1 SET FOR 220/132/33KV SUBSTATION AUXILIARY SYSTEM**

Remote substation shall be identified during detailed engineering stage.

SAS panels shall be placed in 220/132/33kV Control room.

b) Complete relay and protection system for 220kV bays as per Section–Control and Relay panels.

The protection to be provided on 220kV Lines shall be as under;

Main-I Protection shall be distance Protection Scheme as per specification Clause no. 18.8 of section control & Relay Panel.

Main-II Protection shall be Line current differential protection. Specification of **Current Differential protection will be as per Annexure-XI**

**For 220 kV Marsyangdi (Markichowk) Double circuit line, line current differential relay matching with other end are included in other contract.** Further for 220 kV Khudi Double circuit lines, matching differential relays of other end are included in current scope of work as per BPS.

c) For 132kV GIS Bays & 36 kV GIS bays, the requirement & specification for complete relay and protection system shall be as specified for 132kV in Section–Control and Relay panels.

d) Following shall apply for control & relay panel of 36kV GIS bays:

  (i) Only one physical Cabinet/panel shall be supplied for each 36kV Bay which will include CB relay panel, Line/Transformer /BusSection/Incomer protection panel. Bay control unit, Ethernet switch for substation automation system shall be included in the same Cabinet/Panel.

  (ii) Main-I relay for 36kV line protection shall be Line current Differential Relay. Scope shall include matching Line current Differential relay **as per BPS** for remote end of the line.

  (iii) Bus Bar protection as envisaged in the Section- Control & Protection is not required for 33kV Bus Bar. However, LBB protection for 33kV Circuit breakers shall be provided and it can be supplied as built-in function of any protection relay / IED of that bay.
e) Digital protection couplers (DPCs) for both ends of 220kV Lines as per BPS. Scope includes cable required for connecting DPC with the Communication (SDH) equipment in the substation control room building. Specification of DPC is as per Annexure-VII.

For 220 kV Marsyangdi (Markichowk) Double circuit line, DPCs matching with other end are included in other contract. Further for 220 kV Khudi-Udipur line, Hetauda-new Bharatpur and Damauli Double circuit lines, matching DPCs are included in current scope of work.

f) Insulator strings and hardware, clamps & connectors, terminal connector including terminal connectors for Transformers, conductor, earth wire and earthing materials, spacers, cable supporting angles/channels, cable trays & covers, Junction box, cable sealing system, buried cable trenches etc. Calculation of Direct Stroke Lightning Protection (DSLP) is also in the scope of the contractor.

g) Complete Fire Protection system including HVW system for 53.33 MVA, 220/132/33kV 1-Ph Transformers & 50 MVA, 132/33 kV transformer. Further, Hydrant points shall be provided for all Transformers.

h) LT Transformers and associated equipment:-

- 630 kVA, 33/0.400kV, LT Transformer with associated 72.5kV Circuit Breakers, Isolators, Current Transformers, Potential Transformers, Bus Post Insulators, conductor, clamps, connectors etc. complete in all respect for tertiary loading.

- 630 kVA, 33/0.400kV, LT Transformer with associated terminal connectors, Bus Post Insulators, conductor, clamps, connectors etc. complete in all respect for connection with GIS bay.

i) LT switchgear (AC/DC Distribution boards).

j) 100KVA Silent type Outdoor DG Set with AMF Panel.

k) Batteries & Battery Chargers (220V & 48 V). The capacity for batteries and battery chargers shall be worked out by the Contractor for the present and future bays as shown in the Single Line Diagram of the substation and shall be subject to Owner's approval. However, the capacity for battery & ratings for battery chargers shall not be less than the capacity & rating mentioned below.

- 220V Battery – 600 AH
- 220V Float cum Boost Charger – 80A/80A
- 48V Battery – 600 AH
- 48V Float cum Boost Charger – 80A/80A

(e) 1.1 kV grade Power & Control cables along with complete accessories.
(f) Air Conditioning System for the control room building and panel room of 220kV, 132 kV & 33kV. The requirement of air conditioning system for relay panel room of GIS building shall be as per Annexure-III.

(g) Ventilation system for 220kV GIS, 132 kV & 33kV GIS Buildings.

(h) Lattice and pipe structures (galvanized): 220/132/33kV Towers, Beams and equipment support structure shall be provided as per design and drawings to be developed by the contractor. However supply of support structure for 72.5 kV circuit breaker is under scope of CB manufacturer as per their design. For other equipment, the support structures shall be of pipe structures.

(i) Bus Post Insulators, insulator strings and hardware, clamps & connectors, Equipment terminal connectors, Conductors, Aluminum tubes, Bus bar and earthing materials, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches.

(j) Complete lighting and illumination for the switchyard including street Lightning, Control Room cum administrative building, Switchyard Panel Room, Fire Fighting Pump house, Transit camp & residential quarters.

(k) Earth mat design & laying inside the GIS buildings and in the outdoor yard and lightning protection system.

(l) Telecommunication equipment as per bid price schedule.

(m) Oil filtration plant (ref Annexure-X).

(n) Any other equipment/material required to complete the specified scope.

2.2.1.2 Civil Works - The scope of work shall include but shall not be limited to the following based on design and drawings to be developed by the contractor:-

(a) GIS Building for 220kV, 132 kV & 33kV GIS. The size of 220kV GIS Building shall be suitable to accommodate Eleven (Six present plus five future) numbers bays in addition to the maintenance bay. The size of 132kV GIS Building shall be suitable to accommodate thirteen (Ten present plus three future) numbers 132kV bays in addition to the maintenance bay. The size of 33kV GIS Building shall be suitable to accommodate Ten numbers 33kV bays in addition to the maintenance bay. EOT crane shall be provided in the 220kV, 132 GIS Building as per relevant section of technical specification. The Relay room shall be provided for 220kV, 132 kV & 33kV GIS Building.

(b) All civil works including foundations associated with SF6 gas insulated metal enclosed switchgear along with its ducts.

(c) Foundation for Bus duct supporting structures, GIS (SF6 to Air) bushing, lighting poles, panels and control cubicles of equipment wherever required.

(d) Cable trenches inside GIS buildings.

(e) Foundations of 220/132/33 kV Auto Transformers, 132/33kV Transformers, along with jacking pad and pylon supports, rail track and fire resistant wall between Transformers etc.
f) Foundation for all towers, equipment support structures, LT Transformers and DG set.

g) Cable trenches along with covers, road/rail crossings, sump pits and cable trench crossings with roads or drains etc.

h) All roads as shown in GA drawing including culverts. Roads within boundary wall shall be RCC type.

i) Antiweed treatment, PCC and Stone spreading in switchyard area.

j) Control room cum administrative building, Building for fire fighting pump house and fire water tank, Underground water tanks, Car parking sheds, Transit camp & residential quarters.

k) Drains along with drain crossings with cable trenches. Drain layout shall be developed by the contractor.

l) Fencing for switchyard and switch yard gates.

m) Layout and details of Water supply and Sewage system.

n) Dewatering pumps,

o) Soil investigation.

p) Contouring and Site leveling: The leveling in the area under present scope of work inside substation boundary wall is to be carried out to achieve finished ground level. The leveling area and finished ground level of switchyard shall be decided during detailed engineering stage. The leveling area shall be leveled in single or multi level as per topographical features/contouring details of substation land.

q) Security room along with septic tank & soak pit.

r) Store room

s) Construction of random rubble masonry retaining walls

t) Foundation for lighting poles, Bay marshalling box, panels and control cubicles of equipment wherever required

2.2.2 New 220kV GIS type (Gas Insulated Substation) and extension 132 kV AIS substation at 132 kV Bharatpur substation

2.2.2.1 Design, engineering, manufacture, testing, supply including transportation & insurance, storage, erection, testing and commissioning of following equipment and items complete in all respect:

2.2.2.1.1 245kV Gas Insulated Switchgear

245 kV SF6 gas insulated switch gear shall have double main bus bar arrangement. The Switchgear (50 Hz) shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring,
grounding connections, gas monitoring equipment & piping and support structures along with necessary base plate & foundation bolts.

The SF6 gas insulated switch gear (50 Hz) shall be of the indoor metal- enclosed type, comprising of following modules:-

a) Three/Single isolated phase, 4000A, 40kA for 1 second, SF6 gas-insulated metal enclosed bus bar of 245kV along with bus PT, each set comprising of the following:-

(i) Three (3) individual 1-phase/ one (1) 3-phase bus bars enclosures running the length of the switch gear to interconnect each of the circuit breaker bay modules in Double Bus bar system.

(ii) One (1) number 3-phase, 1600A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

(iii) One (1) number 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(iv) Three (3) numbers 1-phase Potential Transformers with motorized isolating link.

(v) Gas monitoring devices, barriers, pressure switches, UHF PD Sensors etc. as required.

(vi) End Piece module with the test link for Future extension of Bus bar module at one end. The end piece module may be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. In case, 245kV Main Bus bar is offered with 3-ph enclosure, extension piece module shall include Adapter module to convert it to three individual 1-ph bus bar enclosures and same shall be deemed to be included in 245kV Bus Bar module

(vii) Local control cubicle, if required separately.

b) 245kV, 40kA for 1 second, SF6 gas-insulated metal enclosed ICT bay module each set comprising of the following:-

i. One (1) number 3-phase, 1600A, SF6 insulated circuit breaker without PIR complete with operating mechanism.

ii. Three (3) numbers 1-phase, 1600A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

iii. Three (3) numbers 3-phase, 1600A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

iv. Three (3) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
v. Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

vi. Local Control Cubicle.

c) **245kV, 40kA** for 1 second, SF6 gas-insulated metal enclosed Line bay module each set comprising of the following:

(i) One (1) number 3-phase, 1600A/2400A (as per BPS), SF6 insulated circuit breaker without PIR complete with operating mechanism.

(ii) Three (3) numbers 1-phase, 1600A/2400A (as per BPS), 6-core (4 for protection & 2 for metering), current transformers duly distributed on both side of circuit breaker.

(iii) Three (3) numbers 3-phase, 1600A/2400A (as per BPS), group operated isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Three (3) numbers 1-phase Potential Transformers (with four secondary i.e. 2 for protection and 2 for metering) with motorized isolating link

(v) Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(vi) One (1) number 3-phase, high speed fault make grounding switch, complete with group operated manual and motor driven operating mechanisms.

(vii) Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

(viii) Local Control Cubicle.

d) **245kV, 40kA** for 1 second, SF6 gas-insulated metal enclosed Bus Coupler bay module each set comprising of the following:

(i) One (1) number 3-phase, 4000A, SF6 insulated circuit breaker without PIR complete with operating mechanism.

(ii) Three (3) numbers 1-phase, 4000A, 5-core, multi ratio, current transformers duly distributed on both side of circuit breaker.

(iii) Two (2) numbers 3-phase, 4000A, group operated isolator switches, complete with manual and motor driven operating mechanisms.

(iv) Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

(v) Gas monitoring devices, barriers, pressure switches UHF PD Sensors etc. as required.

(vi) Local Control Cubicle.
The Switchgear shall be complete with all necessary terminal boxes, SF₆ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures. In addition all necessary platforms, supports, ladders and catwalks etc. for operation & maintenance work shall also be supplied.

e) **245kV Gas Insulated Bus (GIB) Ducts:**

245kV Gas Insulated Single phase enclosure Bus Duct (Including support structure, gas monitoring device, gas barrier, UHF PD Sensor etc.) from GIS building to Centre line of SF6/Air Bushing shall be as per BPS. Sf6 gas duct inside GIS building are part of respective GIS Module.

A tentative layout /GA drawing (drawing No C/ENG/NEPAL/ Bharatpur GIS/Layout/001, Rev. 00) of the switchyard is enclosed with this specification for 220/132 kV Bharatpur Substation. The GIB duct length shall be optimized further without affecting the switchyard arrangement and bay orientation and also any of the functional requirements specified.

f) **245kV Gas Insulated SF6 to Air Termination:**

   (i) 245kV, 1600A/2400A (as per BPS), 1-phase SF₆ to air bushings for outdoor overhead connections. The cantilever strength of the 245kV SF₆ to air bushings shall be of minimum 8kN.

g) Testing and Maintenance Equipment as per BPS (Bid Price Schedule).

h) Mandatory Spares as per BPS (Bid Price Schedule).

i) Any other equipment/material required to complete the specified GIS scope of work.

j) Any other equipment/material required to complete the specified GIS scope of work.

During Engineering contractor is required to furnish the detailed document enlisting each and every GIS Module (indoor and outdoor) complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc. identifiable. The Purpose of above said document is to identify (as a part no.) each and every GIS Module individually in supplied GIS installation.

The bidder shall note that the conductor terminating at Bharatpur SS is HTLS ACCC Drake. So substation scope shall incorporate the suitable/required equipment, hardware and accessories etc suitable for HTLS ACCC Drake conductor.

2.2.2.1.2 **Air insulated switchgear(AIS) and Other Main Equipment**

(a) 2 (Two) numbers of 160 MVA, 220/132/33kV, 3-phase auto- transformers.
(b) 1 (one) number 630KVA, 33/0.400kV LT transformer along with associated equipment

(c) For 245kV, 145 kV system Circuit breaker, Isolators, CT, Surge Arrestors and Bus Post Insulators, 72.5kV circuit breakers, isolators, earth switches, current transformers, capacitor voltage transformers, PT and surge arresters for tertiary loading as per BPS.

(d) For 220kV/132kV/33kV Sub-station automation system including hardware and software for local as well as remote control station along with associated equipment for following bays (bay as defined in Technical Specification, Section - Substation Automation).

- **BCU FOR 245KV- 13 NUMBER BAYS , 132 KV BAYS-9 (2 NOS TRANSFORMER BAYS AND 7 NOS EXISTING BAYS) - 1 SET FOR 220/132/33KV SUBSTATION AUXILIARY SYSTEM**

  The existing 132 kV Substation at Bharatpur is conventional type (Without substation automation). All the control activities for existing substation is to be done from the exiting Control room. For Substation automation for existing 132 kV bays including necessary BCU, hardware, software and their integration is under present scope of work. Further, the automation system for 132 kV bays shall have provision for future integration of one number protection IEDs per feeder bays.

  Remote substation shall be identified during detailed engineering stage.

  SAS panels shall be placed in existing Control room.

(e) Complete relay and protection system for 220kV bays as per Section–Control and Relay panels.

  The protection for 220kV Damauli double circuit Lines and 220kV Marsyangdi (Markichowk) Double circuit lines shall be as under;

  Main-I Protection shall be distance Protection Scheme as per specification Clause no. 18.8 of section control & Relay Panel.

  Main-II Protection shall be Line current differential protection. Specification of **Current Differential protection will be as per Annexure-XI**

  For 220 kV Marsyangdi (Markichowk) Double circuit lines, line current differential relay matching with other end are included in other contract. Further for 220 kV Damauli Double circuit lines, matching differential relays of other end are included in current scope of work

(f) For 132kV Bays, the requirement & specification for complete relay and protection system shall be as specified for 132kV in Section–Control and Relay panels.

(g) Digital protection couplers (DPCs) for both ends of 220kV Lines as per BPS. Scope includes cable required for connecting DPC with the Communication
(SDH) equipment in the substation control room building. Specification of DPC is as per Annexure-VII

For 220 kV Marsyangdi (Markichowk) Double circuit lines & New Bhutwal Double circuit lines, DPCs matching with other end are included in other contract. Matching DPCs for Hetauda and Damauli ends have been included in current scope of work.

(h) Insulator strings and hardware, clamps & connectors, terminal connector including terminal connectors for Transformers, conductor, earth wire and earthing materials, spacers, cable supporting angles/channels, cable trays & covers, Junction box, cable sealing system, buried cable trenches etc. Calculation of Direct Stroke Lightning Protection (DSLP) is also in the scope of the contractor.

(i) Complete Fire Protection system including HVW system for 160MVA, 220/132/33kV 3-Ph Auto Transformers. Further, Hydrant points shall be provided for all Transformers.

(j) LT Transformers and associated equipment:-

630 kVA, 33/0.400kV, LT Transformer with associated 72.5kV Circuit Breakers, Isolators, Current Transformers, Potential Transformers, Bus Post Insulators, conductor, clamps, connectors etc. complete in all respect for tertiary loading.

(k) LT switchgear (AC/DC Distribution boards).

(l) 100KVA Silent type Outdoor DG Set with AMF Panel.

(m) Batteries & Battery Chargers (220V & 48 V). The capacity for batteries and battery chargers shall be worked out by the Contractor for the present and future bays as shown in the Single Line Diagram of the substation and shall be subject to Owner’s approval. However, the capacity for battery & ratings for battery chargers shall not be less than the capacity & rating mentioned below.

i) 220V Battery – 600 AH

ii) 220V Float cum Boost Charger – 80A/80A

iii) 48V Battery – 600 AH

iv) 48V Float cum Boost Charger – 80A/80A

(n) 1.1 kV grade Power & Control cables along with complete accessories..

(o) Air Conditioning System for the control room building and panel room of 220k. The requirement of air conditioning system for relay panel room of GIS building shall be as per Annexure-III.
(p) Ventilation system for 220kV GIS Buildings.

(q) Earth mat design & laying inside the GIS buildings and in the outdoor yard is in the scope of Contractor.

(r) Lattice and pipe structures (galvanized): 220/132kV Towers, Beams and equipment support structure shall be provided as per design and drawings to be developed by the contractor. However supply of support structure for 132 kV & 72.5 kV circuit breaker is under scope of CB manufacturer as per their design. For other equipment, the support structures shall be of pipe structures.

(s) Bus Post Insulators, insulator strings and hardware, clamps & connectors, Equipment terminal connectors, Conductors, Aluminum tubes, Bus bar and earthing materials, spacers, cable supporting angles/channels, Cable trays & covers, Junction box, buried cable trenches.

(t) Complete lighting and illumination for the switchyard including street Lightning, Control Room cum administrative building, Switchyard Panel Room, Fire Fighting Pump house, Transit camp & residential quarters.

(u) Earth mat design & laying inside the GIS buildings and in the outdoor yard and lightning protection system

(v) Telecommunication equipment as per bid price schedule

(w) Oil filtration plant (ref Annexure-X)

(x) Any other equipment/material required to complete the specified scope.

2.2.2.2 Civil Works - The scope of work shall include but shall not be limited to the following based on design and drawings to be developed by the contractor:

a) GIS Building for 220kV GIS. The size of 220kV GIS Building shall be suitable to accommodate Thirteen numbers bays in addition to the maintenance bay. EOT crane shall be provided in the 220kV GIS Building as per relevant section of technical specification. The Relay room shall be provided for 220kV GIS Building.

b) All civil works including foundations associated with SF6 gas insulated metal enclosed switchgear along with its ducts.

c) Foundation for Bus duct supporting structures, GIS (SF6 to Air) bushing, lighting poles, panels and control cubicles of equipment wherever required.

d) Cable trenches inside GIS buildings.

e) Foundations of 220/132/33 kV Auto Transformers along with jacking pad and pylon supports, rail track and fire resistant wall between Transformers etc

f) Foundation for all towers, equipment support structures, LT Transformers and DG set.
g) Cable trenches along with covers, road/rail crossings, sump pits and cable trench crossings with roads or drains etc.

h) All roads as shown in GA drawing including culverts. Roads within boundary wall shall be RCC type.

i) Anti-weed treatment, PCC and Stone spreading in switchyard area.

j) Control room cum administrative building, Building for firefighting pump house and fire water tank, Underground water tanks, Car parking sheds, Transit camp & residential quarters, closed, Semi – closed &.

k) Drains along with drain crossings with cable trenches. Drain layout shall be developed by the contractor.

l) Fencing for switchyard and switchyard gates.

m) Layout and details of Water supply and Sewage system.

n) Dewatering pumps,

o) Soil investigation.

p) Contouring and Site leveling: The leveling in the area under present scope of work inside substation boundary wall is to be carried out to achieve finished ground level. The leveling area and finished ground level of switchyard shall be decided during detailed engineering stage. The leveling area shall be leveled in single or multi level as per topographical features/contouring details of substation land.

q) Security room along with septic tank & soak pit.

r) Store room & open store

s) Construction of random rubble masonry retaining walls

t) Foundation for lighting poles, Bay marshalling box, panels and control cubicles of equipment wherever required

2.3 The bidders are advised to visit the substation sites and acquaint themselves with the topography, infrastructure and also the design philosophy bidding. Before proceeding with the construction work of the Sub-stations, the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the Owner shall endeavor to provide the information, it shall not be binding for the Owner to provide the same. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substation in all respects. All materials required for the Civil and construction/installation work shall be supplied by the Contractor. The cement and steel shall also be supplied by the Contractor.

The complete design (unless specified otherwise in specification elsewhere) and detailed engineering shall be done by the Contractor based on conceptual
tender drawings. Drawings for civil works enclosed with tender drawings are for information only. However civil and architectural drawings shall be developed by the contractor as per his design.

2.4 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, training of Owner’s manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the substation/switchyard.

2.5 Design of substation and its associated electrical & mechanical auxiliaries systems includes preparation of single line diagrams and electrical layouts including layout arrangement for transformers, foundation layout, cable trench layout, earthmat layout, erection key diagrams, electrical and physical clearance diagrams, design calculations for earthing and lightening protection system (including Direct Stroke Lighting Protection), control and protection schematics, wiring and termination schedules, civil designs (as applicable) and drawings, design of fire fighting system and air conditioning system, indoor/outdoor lighting/illumination and other relevant drawings & documents required for engineering of all facilities within the fencing to be provided under this contract, are covered under the scope of the Contractor.

2.6 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the substation are deemed to be included in the scope of the specification unless specifically excluded.

2.7 Owner has standardized its technical specification for various equipment and works for different voltage levels. Items, which are not applicable for the scope of this package as per schedule of quantities described in BPS, the technical specification for such items should not be referred to.

3.0 SPECIFIC EXCLUSIONS

The following items of work are specifically excluded from the scope of the specifications for all substations:

(a) Owner's site office,

(b) Cutting and clearing of trees and bushes in yard

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 Meteorological data or Udipur & Bharatpur :-

a) Altitude above sea level :
   i) less than 1000m from MSL

b) Ambient Air Temperature :
   45°C(max)/ 0 °C(min)

c) Average Humidity (in %) :
   95 (max), 40(min)
d) The substation locations are lying in the wind speed Zone 4 i.e. 47m/s.

e) Seismic Requirement for Substations: 0.5g (Horizontal peak acceleration value).

However, for design purposes, ambient temperature should be considered as 50 degree centigrade and Relative humidity 100% for both the substation.

4.2 The fault level of all equipment to be supplied under present scope shall be as indicated below:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Voltage Level</th>
<th>Fault Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>220kV</td>
<td>40kA for 1 Sec</td>
</tr>
<tr>
<td>2</td>
<td>132kV</td>
<td>31.5kA for 1 Sec</td>
</tr>
<tr>
<td>3</td>
<td>33kV</td>
<td>31.5kA for 1 Sec</td>
</tr>
</tbody>
</table>

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipment and civil works are indicated in Bid price Schedules.

All equipment/items and civil works for which bill of quantity has been indicated in BPS (Bid price Schedules) shall be payable on unit rate basis/quoted rate basis. During actual execution, any variation in such quantities shall be payable as per relevant clauses incorporated in Letter of award.

Wherever the quantities of items/works are indicated in LS/Lot/Set, the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Bid price schedules. For erection hardware items, Bidders shall estimate the total requirement of the works and indicate module-wise lump sum price bay wise and include the same in relevant Bid price schedules. For module identification, Bidder may refer typical drawings enclosed with the specifications. Any material/works for the modules not specifically mentioned in the description in BPS, as may be required shall be deemed to be included in the module itself.

The detailed bill of quantities of the mandatory spares is as per BPS.

Bidder should include all such items in the bid proposal sheets, which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful commissioning of substation shall be included in the bid price and shall be provided at no extra cost to Owner.

6.0 BASIC REFERENCE DRAWINGS

6.1 Single line diagram and general arrangements are enclosed with the bid documents for reference, which shall be further engineered by the bidder.
6.2 The reference drawings, which form a part of the specifications, are given at Annexure-I. The bidder shall maintain the overall dimensions of the substation, phase to earth clearance, phase to phase clearance and sectional clearances.

The enclosed drawings give the basic scheme, layout of substation, substation buildings, associated services etc. In case of any discrepancy between the drawings and text of specification, the requirements of text shall prevail in general. However, the Bidder is advised to get these clarified from Owner.

6.3 The auxiliary transformers of rating 630 KVA shall be used to feed the substation auxiliaries.

The 630KVA, 33/0.400kV auxiliary transformers for Udipur substation and Bharatpur shall be located in LT station area. At both the substations HT side of one auxiliary transformer shall be connected with tertiary of 220/1132/33 kV auto transformer bank. At Udipur second 630 kV Transformer will be connected in 36 kV GIS auxiliary transformer bay. These auxiliary transformers should not be used for construction power supply purpose. The detailed scheme is shown in the single line diagram. Provision for adding another LT transformer in future for alternate supply is also required at Bharatpur, as under present scope only one 630 kV LT Transformer is considered.

7.0 ORDER OF PRECEDENCE OF DIFFERENT PARTS OF TECHNICAL SPECIFICATION

For the purpose of present scope of work, technical specification shall consist of following parts and they should be read in conjunction with each other.

<table>
<thead>
<tr>
<th></th>
<th>Chapter</th>
<th>Requirements</th>
<th>Rev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chapter 1 : Project Specification Requirement</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>2</td>
<td>Chapter 2 : General Technical Requirement</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>3</td>
<td>Chapter 3 : Switchgear</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>4</td>
<td>Chapter 4 : LT Switchgear</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>5</td>
<td>Chapter 5 : Battery &amp; Battery Charger</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>6</td>
<td>Chapter 6 : Lighting System</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>7</td>
<td>Chapter 7 : LT Transformer</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>8</td>
<td>Chapter 8 : Fire Protection System</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>9</td>
<td>Chapter 9 : Power &amp; Control Cable</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>10</td>
<td>Chapter 10 : Air Conditioning System</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>11</td>
<td>Chapter 11 : DG Set</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>12</td>
<td>Chapter 12 : Switchyard Erection</td>
<td></td>
<td>00 (NEA)</td>
</tr>
<tr>
<td>13</td>
<td>Chapter 13 : Structure</td>
<td></td>
<td>00 (NEA)</td>
</tr>
</tbody>
</table>
14. Chapter 14: Civil Works  Rev. 00 (NEA)
15. Chapter 15: Control & Relay Panels  Rev. 00 (NEA)
16. Chapter 16: PLCC  Rev. 00 (NEA)
17. Chapter 17: Substation Automation System  Rev. 00 (NEA)
18. Chapter 18: Fibre Optics Based Communication Equipment  Rev. 00 (NEA)
19. Chapter 19: GENERAL TECHNICAL REQUIREMENT (GTR)-TRANSFORMER & REACTOR  Rev. 00 (NEA)
20. Chapter 20: 220KV CLASS SPECIFICATIONS FOR TRANSFORMER (Transformer up to 220 kV class)  Rev. 00 (NEA)
21. Chapter 21: Gas Insulated Switchgear (GIS)  Rev. 00 (NEA)
22. Chapter 22: EHV XLPE POWER CABLE  Rev. 00 (NEA)
23. TESTING AND MAINTENANCE EQUIPMENT  Rev. 00 (NEA)
24. MISCELLANEOUS ITEMS  Rev. 00 (NEA)

In case of any discrepancy between Chapter 1-PSR, Chapter 2-GTR and other technical specifications on scope of works, Chapter 1-PSR shall prevail over all other chapters.

In case of any discrepancy between Chapter 2-GTR and individual chapters for various equipment, requirement of individual equipment chapter shall prevail.

8.0 SPARES

Mandatory Spares

The Mandatory Spares shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedule of BPS and shall be considered for evaluation of bid. It shall not be binding on the Owner to procure all of these mandatory spares.

For GIS mandatory spares, bidders shall ensure each type & rating spare shall be included considering one to one replacement in installation as per actual site condition in case of requirement due to maintenance or failure. Contractor is required to submit an undertaking along with GIS spares that in case of replacement requirement, considered spare against specified mandatory spare include each type and rating and everything necessary for one to one
replacement for complete GIS installation without necessitating any further manufacturing and supply.

The bidder is clarified that no mandatory spares shall be used during the commissioning of the equipment. Any spares required for commissioning purpose shall be arranged by the Contractor. The unutilized spares if any brought for commissioning purpose shall be taken back by the contractor.

9.0 SPECIAL TOOLS AND TACKLES

The bidder shall include in his proposal the supply of all special tools and tackles required for operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. However a list of all such devices should be indicated in the relevant schedule provided in the BPS. In addition to this the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Employer during the operation of such equipment. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized.

10.0 FACILITIES TO BE PROVIDED BY THE OWNER

10.1 Owner shall make available the auxiliary HT power supply from NEA on chargeable basis at a single point in the Sub-station. The prevailing energy rates of the state shall be applicable. All further distribution from the same for construction and permanent auxiliary supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and Owner shall in no case be responsible for any delay in works because of non-availability of power.

10.2 Owner shall make available construction water supply at a single point in the substation. All further distribution for the same shall be made by the Contractor. In case of non-availability or inadequate availability of water for construction work, the contractor shall make his own arrangement at his own cost and the Owner shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

11.0 SPECIFIC REQUIREMENT

11.1 The Bidders are advised to visit Sub-stations site and acquaint themselves with existing facilities, the topography, infrastructure, etc.

11.2 The bidder shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Owner.
The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.

11.3 Augmentation and integration work related to SCADA System

The 220/132kV bays under present scope at both the substations (i.e. Udipur substation & Bharatpur Substation) shall be integrated by the contractor into existing SCADA system of Siemens ‘SINAUT Spectrum’(version 4.3.2) installed at Master Station i.e. Nepal Electricity Authority Load Dispatch Centre (located in Siuchatar, Kathmandu). The integration shall include all hardware and software required at the Control Centre as well as necessary data base, display generation and upgrades for proposed control and monitoring of station and Network Analysis. The above activities shall be carried out as appropriate, in all of the 2 stations viz. The manufacturers of the existing SCADA system are:-

LDC facilities: Siemens Germany

The details of Data acquisition principles (types of analogue /digital data ) for control, monitoring of substation is enclosed at Annexure V. The existing communication protocol used for SCADA at LDC Kathmandu is IEC 101. For the present scope of work, RTU are not envisaged and the Data for SCADA purpose shall be obtained from the Substation Automation System (based on IEC 61850) using Gateway port with communication protocol IEC 101/104 as per requirement being provided at two substations (i.e. substations (i.e. Udipur substation & Bharatpur Substation)) under present contract.

11.4 Augmentation and integration work related to Communication System

The scope of work for supply, installation of Optical Line Termination Equipment, Digital Multiplexer, hardware accessories e.t.c at substations (i.e. Udipur substation & Bharatpur Substation), LDC Kathmandu and its integration work (at LDC Kathmandu) for onward transmission of Data and Voice communication upto LDC Kathmandu is included in the contract. One number PABX shall be supplied and commissioned at each new substations i.e. Udipur substation & Bharatpur Substation. The technical specification is enclosed at Annexure-IV.

11.5 One set ½C x 300 Sq. mm XLPE power cable for oil filtration units of transformers shall be provided along with 250Amps, TPN MCCB receptacles at 220kV new substation i.e. Udipur substation & Bharatpur Substation substations). The cable shall be terminated at 250A MCCB receptacle at one point near Transformer in the yard.

11.6 The Employer intends to carry out Dynamic Short Circuit Test (as Type Test) on all ratings of Power Transformers which shall be payable as per provisions of contract i.e. on one unit 53.33 MVA, 1-phase, 220/132/33kV Autotransformers, 1X50 MVA, 132/33kV, 3-phase Transformer and1X160 MVA, 3-phase, 220/132/33kV Autotransformer.
The price of conducting the test shall be quoted in the relevant schedule of Bid proposal sheet (BPS). The type test charges would be considered for evaluation. In case bidder does not quote any charges, it shall be carried out at no extra cost to Employer. Further, in case bidder indicates that he shall not carry out the test, his offer shall be considered incomplete and shall be liable to be rejected. The Employer reserves the right to witness the type test. The contractor shall submit schedule at least 30 days in advance for conducting type test on the transformer under the contract.

11.7 Erection, testing and commissioning of GIS equipment’s, Circuit breaker, Isolators, Substation automation system, Control and protection Panels, communication equipment & PLCC shall be done by the contractors under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BPS.

11.8 The duct connections should be such that it is possible to remove transformer for repair and maintenance conveniently.

11.9 The price of Bus-duct inside the GIS hall shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Bid Price schedule. Therefore, bidder is required to quote for 220kV GIB (SF6 Gas insulated Bus Duct) of Line/Transformer feeder module required outside GIS hall with support structure and SF6/Air bushing for interconnecting with its respective gantry / equipment (Overhead connection) separately as per provision of Bid price schedule.

11.10 The Contractor shall impart the necessary training to Owner’s Personnel as per following details:-

- **Training at Manufacturer’s works.** The Contractor shall include in the training charges (i) Accommodation charges (ii) payment of per Diem allowance to NEA trainees @ USD 150 per day per trainee for the duration of training abroad towards meals and other incidental expenses and (iii) to and fro economy class air ticket from Nepal to place of training. The duration of training shall be excluding travelling period.

  The training shall be provided at Manufacturer’s works as per following:-

  Syllabus of the training shall be decided after the award of the Contract.

<table>
<thead>
<tr>
<th>SN</th>
<th>Description</th>
<th>Nos. of Trainee</th>
<th>Training duration in days</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Substation Automation System</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Switchyard Equipment (GIS and AIS)-Transformers including GIS equipment, CB, Instrument</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Transformers, LA, Relays and Control & Protection Schemes, Metering Instruments, Switching Devices, Insulators, etc.

3 Telecommunication Equipment (SDH, MUX & NMS (Craft Terminal)) and PLCC and SCADA

4 Transformers including OLTC

5 Book Keeping, Inventory etc shall be decided during Contract negotiation

6 Administration Human Resources etc shall be decided during Contract negotiation

On Job Training in Nepal: The traveling and living expenses of Owner’s personnel for the training programme conducted in Nepal shall be borne by the Owner.

The training shall be provided to Employer’s personnel in the field of erection, testing, operation and maintenance at each substation site (i.e. Udipur and Bharatpur Substations) as per following:

Syllabus of the training shall be decided after the award of the Contract.

<table>
<thead>
<tr>
<th>SN</th>
<th>Description</th>
<th>Nos. of Trainee</th>
<th>Training duration in days</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>i) Control &amp; Protection</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ii) Substation Automation System including integration aspect of existing SCADA (of Siemens supplied SINAUT Spectrum Software) at Load Dispatch Center</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>iii) Switchyard Equipment (GIS &amp; AIS) for Udipur and Bharatpur substation-operation and maintenance of GIS &amp; AIS equipment</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>iv) Telecommunication Equipment (SDH, MUX &amp; NMS (Craft Terminal)) and PLCC</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>v) Transformers from procurement prospective including aspect of design</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Design of Structures and Foundation using conventional methods as well</td>
<td>6</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>
11.11 The architecture drawing & details of the Switchyard panel room is enclosed for information only as per Annexure– I of project specification requirement of technical specification. The civil construction drawing for above shall be developed by the contractor during detail engineering. For illumination in switchyard panel room average Lux level at ground level shall be 300 lux.

11.12 The lighting fixtures for switchyard lighting shall be mounted on LMs wherever LMs are provided. Where LMs are not available, the fixtures may be mounted on Gantry structures or on lighting poles to be provided by the contractor.

11.13 The GIS halls will be illuminated using enclosed type high bay, luminaries having 1X250 watt (for 400kV & below voltage level GIS hall), metal halide fixtures with approximately 1(one) fixture per 20 square meter. Approximately (10) ten numbers Surface mounted 1x 8W bulkhead LED lights shall be provided for the emergency areas, the location of the same shall be decided during detailed engineering. GIS halls shall also be provided with at least two (2) nos of occupancy sensors subject to provision of at least one sensor per 100 sqm to control the lighting. The illumination in the panel room wherein all the relay, protection and Teleprotection panels shall be located will have LED luminaries as specified in section Lighting System.

11.14 The Frequency range for the earthquake spectra shall be as per IEC-62271-300 for Circuit Breaker.

11.15 Transmission line side insulator String (including Hardware) i.e. tension insulator on the line side of the take off gantry for 220kV,132KV lines termination is under the present scope of specification.

11.16 One number portable fire extinguisher (CO2 type) of 4.5 kg shall be provided for each switchyard panel room as per Bid proposal sheet (BPS).

11.17 The Contractor shall provide AC/DC feeders for complete future bays also as per single line diagram in addition to bays under present scope.

11.18 One number each Energy meter for the record and revenue purpose is to be provided for each 220/132/33kV bays (Bus coupler bays to be excluded) at Udipur substation and 220kV bays (Bus coupler bays to be excluded) at Bharatpur Substation under present scope of contract, meeting the requirement as specified at Annexure – VI.
11.19 The reference of IS standard (i.e. Indian Standard) mentioned in the technical specification shall be read as equivalent IEC or BS or equivalent International Standard.

11.20 Non CFC refrigerant shall be utilized for Air conditioning system, offered for Control room building and switchyard panel room is under the scope of contract.

11.21 **Spare Unit Long term storage & switching arrangement:** The spare transformer shall be completely erected, oil filled and commissioned similar to the other Transformers and kept on the foundation after completing all necessary activities for long term storage. Any special maintenance procedure required during long term storage shall be clearly brought out in the instruction manual. All pre commissioning tests on the spare Transformer similar to the unit kept in service shall be carried out by the contractor. Purchaser intends to replace any of the Transformer unit by the completely assembled oil filled spare Transformer fitted with bushings and without physically shifting of the Transformers. As any unit may be designated as the spare, all units must be prepared accordingly. At Udipur GIS substation, scope of work also include spare unit connection with one banks of Transformers , necessary auxiliary buses for 220 kV (part of GIS), 132 kV(part of GIS), 72.5 kV (for connection in Delta formation) and 36 kV( for connection in Neutral formation) and Delta & Neutral formation for one bank is in present scope of work.

11.22 **LIST OF PREFERED SHORTLISTED MAKE/MANUFACTURER:**

“It is preferred that the equipment be supplied from the manufacturers listed in ANNEXURE-II for mentioned equipment/items. The bidders may offer equipment/brands other than those listed in ANNEXURE-II, that are better or equivalent with regard to quality and performance substantiated with appropriate documents.

11.23 The distance protection relays to be supplied for 220kV lines should have feature of load encroachment blinder to safeguard the protection trip during heavy load condition.

11.24 Separate protection relay (IED) shall be provided for 220kV Class Transformer directional over current and earth fault relay (for both HV & MV side). Inbuilt function in any other protection IED / BCU is not acceptable.

11.25 In the Sub-station automation system, each gas tight compartments of 220kV GIS shall be monitored individually per phase basis. In case it is not possible to monitor the gas tight compartment individually in one BCU, the contractor shall supply additional BCU for the monitoring without any additional cost implication to NEA.

11.26 For supply of SF6 Gas, the contractor shall obtain necessary license from the concerned statutory authorities in Nepal. The contractor shall comply with all the legal & statutory requirements as per the local laws for importing, handling & storage of SF6 gas in Nepal. For this purpose NEA shall extend necessary assistance (documentation etc) for obtaining such clearance & licenses, however the complete responsibility for submitting the application and co-ordination with authorities shall be in the scope of contractor.
The Empty gas Cylinders may be taken back by the contractors after filling the gas in GIS compartments. However, in view of the future maintenance requirement, the contractor shall provide the Gas storage capacity equivalent to the Gas used in largest Gas tight GIS Module. Further, the spare Gas shall be supplied in Gas storage cylinders.

In Chapter 2 GTR and other Technical specifications, the term “Purchaser” and/or “Owner” may be read as “Employer”.

**12.0 PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION**

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the Facilities, as mentioned below, shall be attained in accordance with the procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

(i) Pre commissioning: As per relevant Chapters

(ii) Commissioning : Charging of the Facilities at rated voltage

Further, wherever appearing in these specifications, the words – ‘commissioning checks’, ‘installation checks’, ‘site tests’, ‘performance guarantee tests for fire protection system’, are to be considered as ‘pre commissioning checks’.

(iii) Trial-run : Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 72(Seventy two) hours continuously. In case of interruption due to problem / failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 72(Seventy two) hours period start after such rectification.

(iv) Completion : Upon successful completion of Trial-run.

‘Guarantee Test(s)’ and/or ‘Functional Guarantees’ are applicable only for Substation Automation System as specified in Chapter ‘Substation Automation System.’
LIST OF PREFERED (SHORTLISTED) MAKE

It is preferred that the following equipment be supplied from the manufacturers listed hereunder:

(i) **The main protection relays from**: ABB, AREVA, SIEMENS, Fuji and Reyrolle / EusunReyrolle, Toshiba, Mitsubishi or equivalent.

(ii) **Energy Meters from**: ELSTER (ABB), ACTARIS (Schlumberger), EDMI, SIEMENS or equivalent.

(iii) **SF6 Circuit Breakers from**: ABB, AREVA (Formerly ALSTOM), CGL, Hitachi, Siemens, Toshiba/Mitsubishi, LG, Fuji, GE or equivalent.

(iv) **VCB from**: ABB, AREVA, CGL, Hitachi, Siemens, Mitsubishi, LG, Fuji, GE, Schnieder Electric or equivalent.

(v) **On-Load Tap Changer**: The on-load tap-changer (OLTC) to be equipped on the power transformers and associated control equipment shall be from MR Germany or ABB Sweden or equivalent.

The bidders may offer equipment/brands other than those listed above that are better or equivalent with regard to quality and performance substantiated with appropriate documents. The bidder is required to submit all technical information, brochures, test reports of the proposed equipment for assessing equivalence with the shortlisted vendor.
ANNEXURE-III

AIR CONDITIONING SYSTEM FOR GIS

1 GENERAL

1.1 This specification covers supply, installation, testing and commissioning and handing over to POWERGRID of Air conditioning system for the control room building and Local Control rooms in the GIS halls.

1.2 Air conditioning system shall be designed to maintain the inside DBT below 24°C.

1.3 At least 50% spare AC units shall be provided for control room, Battery room, Local Control rooms in the GIS halls.

1.4 Following areas shall be Air conditioned inside the control room:

   1.4.1 Control Room
   1.4.2 Battery Room
   1.4.3 Conference Room
   1.4.4 Room for Executives and non-executives
   1.4.5 Sub-station in charge plus PS room
   1.4.6 Lobby

1.5 Controllers shall be provided in Local Control room inside GIS hall, Control room and Battery room for controlling and monitoring the AC units in these rooms as detailed in clause no.2.5

1.6 Each Local Control room inside GIS hall, Battery Room and control room shall be provided with temperature transducer to monitor the temperature of the Local Control rooms in the GIS halls. The Temperature transducer shall have the following specification:

   Sensor : Air temperature sensor (indoor use)
   Output : 4 to 20mA
   Temperature range : -5°C to 60°C
   Resolution : 0.1°C
   Accuracy : 0.5°C or better.

2 AIR CONDITIONING SYSTEM REQUIREMENTS.

2.1 Air conditioning requirement of the buildings shall be met using a combination of following types Air Conditioning units as required.

   a) Cassette type split AC units of 3TR.
2.2 **Scope**

The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

2.2.1 Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.

2.2.2 Required number of High wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

2.2.3 Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.

2.2.4 First charge of refrigerant and oil shall be supplied with the unit.

2.2.5 GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.

2.2.6 Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.

2.2.7 All instruments and local control panels alongwith controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.

2.2.8 PVC drain piping from the indoor units upto the nearest drain point.

2.2.9 Supply and erection of Power and control cable and earthing.

2.2.10 MS Brackets for outdoor condensing units, condensers as required.

b) High wall type split AC units of 2TR.
2.3 Technical specifications.

2.3.1 Cassette type split AC units.

The Cassette type AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.3.1.1 Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.3.1.2 Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi-function cordless remote control unit with special features like programmable timer, sleep mode etc.

2.3.1.3 Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and their EER shall not be less than 2.7.

2.3.2 High wall type split AC units

2.3.2.1 The split AC units shall be complete with indoor evaporator unit, outdoor Condensing units and cordless remote control units.

2.3.2.2 Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.3.2.3 The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.

2.3.2.4 Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency rating of 3star or above.

2.4 The Split AC units shall be of Carrier, Voltas, Blue Star, Hitachi, Daikin,
LG, National, O'General, or Samsung make.

2.5 Controllers shall be provided in Local Control room inside GIS hall, Control room and Battery room, one controller for each room, to control and monitoring of AC units and shall have the following facilities:

- Standby units shall come in to operation automatically when the running main unit fails
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.
- Following alarms shall be provided:
  a. Compressor On/OFF condition of each unit
  b. Compressor failure of each unit
  c. Power OFF to AC unit
  d. High temperature in room.

2.6 **Warranty**
All compressors shall have minimum 5 years Warranty from the date of commissioning.
ANNEXURE IV
TECHNICAL SPECIFICATION OF PABX EQUIPMENT

1.1 General

This section provides the functional and performance requirements for the PABX system. The Bidder is encouraged to propose any hardware configurations better suited to the characteristics of the Bidder's standard products as long as the equipment characteristic requirements of this specification are met.

The PABX must be capable of operating in the high EMI environment of substations and power plants, and without air conditioning. The bidder shall provided performance certificate from at least one customer for satisfactory operation of one year.

The Contractor shall be responsible for the installation and implementation of the PABX provided under this procurement along with the interfaces, associated hardware & accessories. This shall include the development of the database, system tests and training of Employer staff.

The following are the minimum requirements for PABX system.

1.2 Technical Requirement

The Contractor shall be responsible for providing state of the art TDM/PCM based PABX system. The offered PABX shall be modular in nature with universal slot architecture to facilitate future expansion requirements. Expansion shall require only procurement and installation of respective interface cards.

The exchange transmission performance shall comply with the ITU-T standards. The Contractor shall provide the details of standards conforming to the product supplied. The offered PABX must be capable of interfacing with 4-wire E&M VF channels provided by Power Line Carrier System (PLCC), E1 (G.703) / Ethernet channels provided by wideband communication equipment and 2 wire LS or 4 wire E&M channels provided by primary multiplexers. The PABX shall also be designed to operate over 2 wire leased telephone land line of other telecommunication provider.

All interfacing equipment necessary for satisfactory operation and to comply with the local regulation shall be provided under this procurement.

The Contractor shall ensure that the speech level and signal-to-noise ratio are satisfactory under all conditions likely to be encountered on the system. The offered PABX shall be integrated with existing PABXs. Any interfaces required for proper matching and connection with existing PABX equipment shall be provided by the Contractor. It shall support at a minimum the following features:

(a) SPC (Stored Program Control) type
(b) 100% non blocking switch with PCM-TDM
(c) Redundant processors or distributed processing architecture
(d) 2 Wire interfaces for local subscribers & remote subscriber
(e) 4 Wire E&M interfaces for two way trunks
(f) Extensions should be extendable over a distance of 300 meters
(g) E1 Interface using Electrical (through copper cable) connection to existing SDH equipments.
(h) Provision of suitable interface for VOIP connectivity (50 Nos)
(i) Printer interface
(j) Extensions shall support DTMF & Pulse dial phones
(k) Extensions shall support analog phones/fax machines
(l) Ringer/Tone card for different tones and ring generation
(m) DID (Direct Inward dialing)
(n) DOD (Direct Outward dialing)
(o) Executive Override enabled
(p) Provision of Voice mail
(q) Call forwarding and Call pickup
(r) Circular hunting within a defined group
(s) Automatic call back
(t) Calling Line Identification Presentation (CLIP) support
(u) Howler tone for receiver-not-on-hook warning

The Contractor shall provide the suitable system for PABX configuration such as class of service, feature assignment, line and trunk access etc. Further, it shall be possible to make on-line changes to the database and shall be user friendly. In case, the bidder offers a PC based PABX configuration system, the PC/workstation shall be of reputed make (Compaq/HP/IBM/Dell) with 15” TFT Color monitor.

The Contractor shall install the telephone extensions as well as terminate the voice trunks along with requisite cable, PVC conduit/channels and other installation hardware. The PABX shall be supplied with a MDF which may be housed inside the PABX cabinet or in a separate enclosure suitable for wall mounting.

The PABX shall be able to operate on -48 Volt DC (nominal). It shall have power supply and control cards in hot-standby mode so that in case of failure of one the other takes over automatically. Alternatively, distributed power supply architecture is also acceptable.

1.3 Equipment Availability: PABX system shall have 99.99% availability. Equipment shall be capable of providing suitable alarm indication in order to determine malfunction/fault condition.

1.4 Testing & Inspection:

The offered PABX shall be type tested as per relevant standards. The bidder shall submit the previous type test reports. The FAT & SAT for PABX shall be conducted as per requirement specified in this Section.

1.5 Factory Acceptance Tests

Factory acceptance tests shall be conducted on final assemblies of all equipment to be supplied.

Equipment/Material shall not be dispatched to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance
Certificate (MICC). Successful completion of the factory tests and the Employer approval to dispatch shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's/Owner's authorised representatives.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. The factory acceptance tests shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's /supplier's) standard FAT testing program which shall be finalised during detailed during engineering. In general the FAT shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

1.6 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor’s standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

1.7 Site Acceptance Tests (SAT)

The Contractor shall be responsible for carrying out site tests and inspection for all equipment supplied in this contract as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate. The site acceptance tests shall be proposed by the Contractor in accordance with technical specifications and Contractor's(including Sub-Contractor's /supplier's) standard Site Acceptance Testing program which shall be finalised during detailed during engineering. The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified.
ANNEXURE-V
EXISTING RTU BASED SCADA & ITS DATA ACQUISITION

1.0 GENERAL INFORMATION

1.1 Remote Terminal Units

The Load Dispatch Centre (LDC) controls and monitors the network of Integrated Nepal Power System (INPS) via RTUs located at its various outstations.

In addition to the above, two local RTUs have been installed at the LDC: one to handle local-control-center status inputs and analog inputs and outputs; and the other for training, maintenance and testing purposes.

Manufacturers of existing SCADA system are:

LDC facilities: SIEMENS, Germany
RTU facilities: ABB, Germany

1.2 Data acquisition principles for existing Substation

The existing substations are provided with RTU for interfacing of the following supervisory controls and data acquisitions:

Remote Control
- Remote control of all 220/132/33kV circuit breakers.

Status indications
- Status indications of all 220/132kV circuit breakers, busbar and line isolators.
- Status indications of all 33kV line feeders.
Table 1.4 : Alarms to be acquired from each type of bay

<table>
<thead>
<tr>
<th>Type of Alarm</th>
<th>Line Bay</th>
<th>Transformer Bay</th>
<th>Coupler Bay</th>
<th>Busbar</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main protection trip</td>
<td>MPT</td>
<td>MPT</td>
<td>MPT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back-up protection trip</td>
<td>BPT</td>
<td>BPT</td>
<td>BPT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bay fault</td>
<td>BFA</td>
<td>BFA</td>
<td>BFA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit breaker fault</td>
<td>CBF</td>
<td>CBF</td>
<td>CBF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto-recloser operated</td>
<td>ARO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Alarm</td>
<td></td>
<td>TAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature Trip</td>
<td></td>
<td>TTR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buchholz alarm</td>
<td></td>
<td>BAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buchholz Trip</td>
<td></td>
<td>BTR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General transformer/reactor alarm</td>
<td></td>
<td>GTA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General transformer/reactor Trip</td>
<td></td>
<td>GTT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Busbar Voltage status</td>
<td></td>
<td></td>
<td></td>
<td>BVS</td>
<td></td>
</tr>
<tr>
<td>Station urgent fault</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SUF</td>
</tr>
<tr>
<td>Station non-urgent fault</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SNF</td>
</tr>
<tr>
<td>Station Control disabled</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SCD</td>
</tr>
<tr>
<td>RTU alarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RTU</td>
</tr>
<tr>
<td>Communication alarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>COM</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>10</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Measurements

- Busbar voltages (separate for each busbar and section) of all 220/132/33 kV Busbars.
- Active/reactive power for
  - All 220kV & 132kV Line feeders.
  - All 220kV, 132kV and 33kV Transformer feeders.
- Single phase current measurements for all 33kV lines participating in load shedding Scheme.
Annexure-VI

Specification for Revenue Meter & Metering (Instrument) Transformer

General

The units shall be suitable for operating in Outdoor environment and shall be manufactured by International Reputed ISO 9001 Company

Energy Meter

The Energy Meter shall have the following minimum requirement

<table>
<thead>
<tr>
<th>Type</th>
<th>Electronic, 3Phase, 4wire, Wye Connection, Bi-directional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy Class</td>
<td>0.1</td>
</tr>
<tr>
<td>Applicable Standard</td>
<td>IEC 687 (latest edition) or Equivalent</td>
</tr>
<tr>
<td>Measurement</td>
<td>a) Polyphase Quantities kWh, kVARh, kVAh</td>
</tr>
<tr>
<td></td>
<td>b) Instantaneous Quantities Real Time, kW, kVA, PF, Volts, Amps, Frequency</td>
</tr>
<tr>
<td>Rated Current (In)</td>
<td>5A or 1A</td>
</tr>
<tr>
<td>Rated Maximum Current</td>
<td>1.2*In</td>
</tr>
<tr>
<td>Starting Current</td>
<td>0.001*In</td>
</tr>
<tr>
<td>Voltage (Phase)</td>
<td>110V/√3</td>
</tr>
<tr>
<td>Frequency</td>
<td>50Hz</td>
</tr>
<tr>
<td>Programmable Interval length</td>
<td>At least 1 to 30 min</td>
</tr>
<tr>
<td>Load Profile Memory Storage</td>
<td>At Least 60 days of storage using 4 channels at 15min intervals</td>
</tr>
<tr>
<td>Channels of Load Profile Data</td>
<td>At Least 4 channels of storage (kWh import, kWh export, kVARh Import, kVARh export)</td>
</tr>
<tr>
<td>Other Features to be Included</td>
<td>a) Serial communication port and Accessories</td>
</tr>
<tr>
<td></td>
<td>b) Optical Port Communication (With optical Probe)</td>
</tr>
<tr>
<td></td>
<td>c) Remote Download Modem (in built)</td>
</tr>
<tr>
<td></td>
<td>d) Hardware Key to Prevent any Calibration and configuration change</td>
</tr>
<tr>
<td></td>
<td>e) PT or CT error gain correction</td>
</tr>
<tr>
<td></td>
<td>f) Non Volatile memory</td>
</tr>
<tr>
<td></td>
<td>g) Inbuilt Super capacitor</td>
</tr>
<tr>
<td></td>
<td>h) Meter shall be able to record and store in Non-Volatile memory the instant of Power failure and the instant of supply restoration.</td>
</tr>
</tbody>
</table>
Annexure-VII

SPECIFICATION FOR DIGITAL PROTECTION COUPLER

1.0 Digital protection coupler for protection signalling through optical fibre cable system.

1.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+10%, -10%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Intertripping and Blocking protection schemes of EHV lines.

The protection signalling equipment shall communicate to the remote end interfacing with SDH terminal equipment at its 2Mbps port. It shall provide suitable interfaces for protective relays, which operate at 220/110V DC. Power supply points shall be immune to electromagnetic interface.

1.2 Principle of operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel.

It shall also be possible to initiate a loop test manually at any station by pressing a button on the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.

Proper tripping signal shall always take the priority over the test procedure.
The high speed digital protection signalling equipment shall be designed and provided with following features.

- Shall work in conjunction with SDH terminal equipment.
- It shall communicate on G 703 (E1,2 Mbps)
- Full Duplex operation
- Auto loop facility shall be provided
- Shall meet IEC 60834-1 standard
- Shall be able to transmit upto 4 commands with trip counter simultaneously or sequentially in one 2Mbps channel

Bidder shall quote for protection signalling equipment suitable for 4 commands with separate trip counters for transmit and receive. With regard to trip counters alternate arrangement .i.e. Laptop along with software & all accessories to download events including carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied at each substation under substation package.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC can be either housed in offered Control & Protection Panel / PLCC Panel or in separate panel.

Reports of the following tests as per clause 9.2 of Chapter 2-GTR shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

i) **General equipment interface tests** :

   a) Insulated voltage withstand tests
   b) Damped oscillatory waves disturbance test
   c) Fast transient bursts disturbance test
   d) Electrostatic discharge disturbance test
   e) Radiated electromagnetic field test
   f) RF disturbance emission test

ii) **Specific power supply tests**

   a) Power supply variations
   b) Interruptions
   c) LF disturbance emission
   d) Reverse polarity

iii) **Tele-protection system performance tests**

   a) Security
   b) Dependability
c) Jitter

d) Recovery time

e) Transmission time

f) Alarm functions

g) Temperature and Humidity tests (As per IEC 68-2)
   - Dry heat test (50°C for 8 hours)
   - Low temperature test (-5°C for 8 hours)
   - Damp heat test (40°C/95%RH for 8 hours)

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC 60834-1 and the standards mentioned therein.

iv) Relays

a) Impulse voltage withstand test as per IEC 60255.

b) High frequency disturbance test as per IEC 60255.

The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment & Protection relays and between protection signalling equipment & Communication equipment shall be in the scope of bidder.

The input/output interface to the protection equipment shall be achieved by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2kV rms.

1.4 Major technical Particulars

The major technical particulars of protection signalling equipment shall be as follows.

i) Power supply 48V DC +10%, -10%

ii) Number of commands 4 (four)

iii) Operating time <7 ms

iv) Back to back operate time without propagation delay ≤ 8 ms

v) Interface to Protection relays

<table>
<thead>
<tr>
<th>Input:</th>
<th>Contact Rating:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>250 volts DC</td>
</tr>
<tr>
<td>Maximum current rating</td>
<td>5 amps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output:</th>
<th>Contact Rating:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>250 volts DC</td>
</tr>
<tr>
<td>Rated current</td>
<td>0.1 A DC</td>
</tr>
</tbody>
</table>

   Other parameters: As per IEC-255-0-20

vi) Alarm contact

   | Rated voltage | 250 volts DC |
Rated current : 0.1 A DC
Other parameters : As per IEC-255-0-20

vii) Digital communication interface: G 703(E1)
Technical Specification for 36kV GAS INSULATED SWITCHGEAR

Revision 00
## CONTENTS

<table>
<thead>
<tr>
<th>CL. NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL CHARACTERISTIC</td>
<td>3</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE STANDARDS</td>
<td>4</td>
</tr>
<tr>
<td>3.0</td>
<td>GENERAL DESIGN CRITERIA</td>
<td>4</td>
</tr>
<tr>
<td>4.0</td>
<td>CIRCUIT BREAKERS</td>
<td>10</td>
</tr>
<tr>
<td>5.0</td>
<td>ISOLATORS / EARTHING SWITCHES</td>
<td>11</td>
</tr>
<tr>
<td>6.0</td>
<td>INSTRUMENT TRANSFORMERS &amp; PROTECTION SCHEME</td>
<td>11</td>
</tr>
<tr>
<td>7.0</td>
<td>SWITCHBOARD PANEL</td>
<td>14</td>
</tr>
<tr>
<td>8.0</td>
<td>CABLE TERMINATIONS</td>
<td>14</td>
</tr>
<tr>
<td>9.0</td>
<td>INTERLOCKING FEATURES</td>
<td>14</td>
</tr>
<tr>
<td>10.0</td>
<td>SWITCHBOARD COMPLETION ACCESSORIES</td>
<td>14</td>
</tr>
<tr>
<td>11.0</td>
<td>TESTS</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>TABLES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COREWISE DETAILS OF CTs &amp; PT</td>
<td></td>
</tr>
</tbody>
</table>
1.0 GENERAL CHARACTERISTICS

1.1 The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of it's constituent parts. It should be designed for indoor application with meteorological conditions at site as per Section Project.

1.2 The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included.

1.3 The required overall parameters of GIS are as follows:-

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage</td>
<td>36 kV</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>33 kV</td>
</tr>
<tr>
<td>Rated one minute power frequency withstand voltage</td>
<td>70 kV</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage</td>
<td>170 kV</td>
</tr>
<tr>
<td>Rated Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated busbar/incomer feeder current</td>
<td>2500 A</td>
</tr>
<tr>
<td>Rated outgoing feeder current</td>
<td>1250 A</td>
</tr>
<tr>
<td>Rated bus coupler/Bus Section current</td>
<td>2500 A</td>
</tr>
<tr>
<td>Rated short-time current, 1 sec</td>
<td>31.5 kA</td>
</tr>
<tr>
<td>Rated peak withstand current</td>
<td>65.75 kA</td>
</tr>
<tr>
<td>Rated short-circuit breaking current of circuit breaker</td>
<td>31.5 kA</td>
</tr>
<tr>
<td>Rated short-circuit making current of circuit breaker</td>
<td>100 kA</td>
</tr>
<tr>
<td>Rated operating sequence O-0. 3s-CO-3min-CO</td>
<td>O-0.3s-co-3min-co</td>
</tr>
<tr>
<td>Insulating Gas</td>
<td>SF6</td>
</tr>
<tr>
<td>Degree of Protection:</td>
<td></td>
</tr>
<tr>
<td>HV-live parts</td>
<td>IP65</td>
</tr>
<tr>
<td>Low voltage compartments</td>
<td>IP4X</td>
</tr>
<tr>
<td>Ambient temperature max.</td>
<td>50°C</td>
</tr>
<tr>
<td>Colour</td>
<td>RAL 7032</td>
</tr>
<tr>
<td>Dimensions: max. width</td>
<td>800 mm</td>
</tr>
<tr>
<td>Plug-in bus bar connections</td>
<td>Yes</td>
</tr>
<tr>
<td>Safety features:</td>
<td></td>
</tr>
<tr>
<td>Arc-fault tested</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### Table

<table>
<thead>
<tr>
<th>Integrated pressure relief device</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic level (horizontal acceleration)</td>
<td>0.3 g</td>
</tr>
</tbody>
</table>

### 2.0 REFERENCE STANDARDS

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electrotechnical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening:

- **IEC 62271-200** Gas insulated metal-enclosed switchgear for rated voltage above 1 kV and up to and including 52 kV.
- **IEC 62271-207** Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
- **IEC 60376** New sulphur hexafluoride
- **IEC 62271-100** High voltage alternating current Circuit breakers
- **IEC 62271-1** Common clauses for high voltage Switchgear and control-gear standards
- **IEC 62271-102** Alternating current disconnectors (isolators) and earthing switches
- **IEC 60128** Alternating current disconnectors. Bus-transfer current switching by disconnectors.
- **IEC 60044-1** Current transformers
- **IEC 60044-2** Voltage transformers
- **IEC 60137** Bushings for alternating voltages above 1000 V
- **IEC 62271-209** Cable connections for gas-insulated switchgear
- **IEC 60480** Guide to checking of sulphur hexafluoride taken from electrical equipment
- **IEC 60099 -1/4** Non-linear resistor type arresters for AC systems
- **IEC 60439** Factory-built assemblies of low-voltage switchgear and control Gear.
- **CIGRE-44** Earthing of GIS- an application guide. (Electra no.151,Dec’93).
- **IEC 61639** Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

The components and devices which are not covered by the above standards shall conform to, and comply with, the applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer and the manufacturer shall list all such applicable standards, codes etc.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

### 3.0 GENERAL DESIGN REQUIREMENT
3.1 This specification covers the design, manufacture, assembly, testing at manufacture’s works before dispatch and delivery of metal clad partitioned, SF-6 gas insulated, 36kV double busbar switchboard panel confirming to IEC-62271-200. The switchboard panels for line bays, transformer bays, bus coupler bays, etc. shall be fitted with 36kV Vacuum circuit breakers, three position disconnecting and earthing switches, voltage transformers, current transformer, metering instruments, protection relays, terminal ends for 36kV incoming & outgoing cable feeders etc. as per foregoing specification.

3.2 The scope also includes the installation & commissioning of SF6 Gas insulated switchboard panels along with interconnection/ interpanel wiring from HV as well as 36kV terminal ends jointing/connection with 36kV cables (2-sets i.e. 6 single core cables/2 three core cables) in all panels.

36kV Gas insulated Metal clad switchgear shall be complete with all the accessories for efficient and trouble free operation. The equipment offered shall be safe, reliable and compact to install. The workmanship shall be high order. The circuit breaker, switches and protective device etc shall be latest design so as to ensure rapid and efficient interruption of fault current low arc energy, small arcing time, complete phase segregation and freedom from fire hazards.

3.3 The GIS shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric stress and insulation coordination etc. shall be maintained during design, selection of raw material, manufacturing process etc. so that the GIS provides long life with least maintenance.

The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

3.4 The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

3.5 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. The gas tight barriers shall be clearly marked on the outside of the enclosures.
3.6 The design of double main bus scheme GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate Mechanical support and number of intermediate gas tight compartments as required, shall be provided to ensure equipment and operating personnel’s safety.

3.7 The grounding system for GIS shall be designed and provided as per IEEE-80-2000 and CIGRE- 44 to protect operating staff against any hazardous touch voltages and electromagnetic interferences.

3.8 SWITCHGEAR OPERATOR INTERFACES REQUIREMENTS:

- A standard mechanical user interface, ergonomically Positioned at a convenient height. It must be visible directly without opening of doors etc.
- The user interface comprises all the mechanical, panel-related interfaces and continuous interrogating interlocks.
- All the basic mechanical ON/OFF of CB, Isolator & earth switch operation, manual spring charge of CB must be possible without opening the door to ensure the operator safety.
- Mechanical mimic linked to mechanism should be provided at the panel front door.
- The basic switchgear unit is to be designed for suitable free-standing installation within a GIS room.
- The Interlocking shall be as per IEC.

3.9 FUNCTIONAL INTUITIVE OPERATOR INTERFACE DESIGN:

The SF6 Gas insulated switchgear shall be characterized especially by the following operating features:

- Ergonomic operability
- Logical operation
- Logical function states
- Good visual communication of the overall function and operating states
- Optimum operator guidance
- All operations can be performed optionally via a motor-operated mechanism

The mechanical control panel is located at an optimum height for operation and arranged in a recessed position on the switchgear front. Thus, the operating area is clearly visible while no control elements protrude from the switchgear front. The position of the individual elements has been selected according to their function, i.e. according to their allocation to the corresponding device functions. The elements which form part of a switching device, such as position indicators, crank ports or mechanical push buttons, are visually linked by a specific pattern and integrated in a mimic diagram. Separate control elements and mechanical switch position indicators are available for the following functions:

- Circuit-breaker ON - OFF
- Disconnector ON – OFF-EARTH
3.10 GAS COMPARTMENT TECHNOLOGY:
A Temperature Compensated Gas Monitoring Device shall be provided on the offered GIS to constantly monitor the Gas Pressure inside the Gas enclosure.
By design there should be no need for gas works during the whole time on site, not even for exchanging a centre panel or extending the switchgear at later stage, e.g. no gas handling shall be necessary during the anticipated service life of the switchgear, under normal operating conditions. (The gas-filled clad compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200).
The switchgear panels shall be filled with gas and checked for leakage in the factory. For a proper recycling / emergency replacement, a gas valve in gas compartment has to be provided. In addition, the standard tools for filling the SF6 Gas also have to be provided.
All the live parts including the VCB, Three position Disconnector, and main busbar shall be encapsulated in metal enclosure filled with SF6 gas.

3.11 INTERNAL ARC:

Equipment shall comply with the requirement of IEC62271-200/ relevant standard for internal arc.
A Pressure relief device is to be additionally provided to improve the level of safety for the operators to a considerable extent.
The ability of the enclosure to withstand pressure shall fulfil the requirements of applicable IEC/relevant standards.
Under fault conditions there must be no emissions of gas and/or materials hazardous for service personnel.

3.12 BUS BARS:

a) Bus bars must be made up of electrolytic copper. Bus bar system must be three-phase, sized to support short-circuit currents of 31.5 kA for 1 sec. Bus bars shall be tubular type in construction and shall be bare and insulated with SF6 gas only.
b) Rating of Bus bars shall be 2500A.
c) 36kV GIS shall be able to withstand rated voltage even if SF6 gas in any of gas insulated compartments leaks to atmospheric pressure.
d) Bus bar fixing arrangement shall be of plug in type and shall not require any gas work at site during erection, testing and commissioning.

3.13 PANEL HOUSING DESCRIPTION:

3.13.1 GENERAL:

a) The switchgear shall be an indoor gas-insulated and metalclad cubicle design with double bus bar system as per scope. It shall be suitable for local and remote control.
b) The switchgear shall be designed to ensure optimum continuity and reliability of supply as well as safety for operation.
c) The switchgear shall be partitioned both between the busbars and the circuit breaker and from panel to panel.

d) The busbar connections between each panel shall be of the plug-in type. The switchgear assembly shall be such that there is no need of any gas handling at site.

e) Pressure relief device above the busbar compartment(s) and at the rear of the panels are required.

f) The power cables shall be fed in from the bottom and connected by plug connectors. A free slot / Isolating link shall be available for cable testing and current and voltage injection. The cable compartment shall have a pressure relief system leading to the pressure relief device at the rear.

g) A leakage rate should not exceed 0.5% per annum. The gas enclosures should therefore be manufactured according to the latest state of the art technology.

h) The switchgear is to be designed in such a way that all high voltage parts with the exception of cable plugs are located in an insulating inert gas, in order to avoid environmental influences such as humidity, dust and otherwise polluted air to prevent metal and gumming of greases.

i) For operator safety the switchgear must have an active and passive protection system against internal faults in each partitioned compartment.

j) In case of an internal fault the active system (in combination with the BAY PROTECTION AND CONTROL UNIT) has to switch off all feeding circuit breakers in a sufficiently short time, which is approx. 100 ms.

k) The SF6 gas pressure detection is to be done by temperature compensated density monitors.

l) The passive safety section shall ensure that hot gases are guided via pressure relief disks from each compartment concerned. The duct ends are guided to open air or fitted with absorbers to cool the hot gases.

m) The temperature-compensated density monitor for pressure measurement shall continuously monitor the relevant gas compartment. Provision must be made for action to be taken when the upper or lower threshold is exceeded, leading to a drastic reduction in damage and internal arc faults.

n) Pressure relief has to be provided for any high voltage compartment. Relief into the cable basement or cavity below a false floor is not permitted.
3.14 **GIS BAY MODULE (SWITCHBOARD/PANEL) DESIGN AND COMPARTMENTS:**

The Switchboard/Panel are to be partitioned into compartments as follows:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Busbar I module (incl. build in 2 or 3 position switches)</td>
<td>GIS compartment</td>
</tr>
<tr>
<td>b)</td>
<td>Busbar II module (incl. build in 2 or 3 position switches in case of double busbar)</td>
<td>GIS compartment</td>
</tr>
<tr>
<td>c)</td>
<td>Core module with built in Vacuum circuit breaker and CT’s</td>
<td>GIS compartment</td>
</tr>
<tr>
<td>d)</td>
<td>33kV Cable termination compartment incl. provisions for conventional VT plug in connection</td>
<td>AIS compartment</td>
</tr>
<tr>
<td>e)</td>
<td>Low voltage compartment including built in Switch operating mechanism, secondary equipment, mimic,</td>
<td>AIS compartment</td>
</tr>
</tbody>
</table>

GIS= Gas Insulated Switchgear       AIS=Air Insulated Switchgear

**Important:**

*For future up rating it must be possible to exchange panels or circuit breakers within an erected switchboard.*

3.15 **MAIN GIS MODULES ARRANGEMENT AND FUNCTIONALITY:**

Each panel shall have a gas-insulated core module and the gas-insulated busbar module (modules).

a) The core module is to contain all HV equipment installed inside gas-insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas-proof compartments preferably for:

1) Circuit breakers
2) Intermediate compartment
3) Gas Insulated section between GIS and XLPE cable

b) The busbars modules is to contain the busbars and the 3 position switch (switches) shall be installed.

3.16 **MAIN AIS MODULES ARRANGEMENT AND FUNCTIONALITY**

a) Each panel shall have a air-insulated core connection compartment and a low voltage compartment.

b) The cable connection compartment is to contain the cable sockets accessible for fitting of the medium voltage cable plugs and the tests cable sockets which also accommodate the plug in voltage transformers if applicable.

c) The low voltage compartment is to contain the switch operating mechanisms and all secondary equipment.

d) The low voltage compartment must be a self-contained unit with its own front door incorporated in the switchgear panel. It is to contain the operating mechanisms and the plug connectors for the auxiliary power and communications.

e) All operating mechanisms have to be motorized. Manual emergency operation and mechanical position indicators shall be provided on the front with mimic.
3.17 INSTALLATION FACILITY:

The panels are to be delivered to site as factory assembled, tested units. After panels (or panel assemblies) have been bolted together and the power and control cables are connected, the system must be ready for operation.

3.18 EXTERNAL COATING OR PAINTING ON THE SWITCHGEAR PANELS:

The visible metal sheets of the switchgear panel enclosures must have an external coat of paint shade RAL 7032. Other metal parts are to be either stainless steel, or suitably coated or painted to prevent rust or corrosion, depending on the material.

3.19 DEGREE OF PROTECTION

The equipment shall be metalclad as defined in IEC 62271-200. The degree of protection shall be at least IP65 for gas compartment and IP4X for the supporting frames, low voltage and other compartments.

4.0 CIRCUIT BREAKERS:

The circuit breaker shall be equipped as follows:

i. The circuit breakers shall be of Vacuum Type, triple pole comply with IEC Publication 6227-100. The operating mechanism of the circuit-breaker shall be stored energy, free release, with pre-charged closing springs, motor/manual operated type. The closing and opening operations must be independent of the operator action. Re-closing locking device must be provided.

ii. Circuit breaker shall be C2 – M2-E1 class as per IEC 62271-100.

iii. The stationary mounted circuit breakers shall be fully type-tested. Test certificates, as evidence of successful completion of type tests shall be submitted with the tender.

iv. The circuit-breakers shall be free release type with re-closing locking device.

v. Internal parts (main and arcing contacts) of circuit breakers must be accessible for maintenance simply removing front cover, with no operations on SF6 compartments. This maintenance operation shall be carried out by skilled personnel only, both on energized or out of service switchboards.

vi. The circuit-breakers shall be present to mount the locks foreseen under point 10 and must also be fitted with accessories hereunder indicated:

- Manual opening/closing mechanism
- Electrical opening/closing mechanism with spring-loading gear motor
- Auxiliary contacts
- Key lock
- Operation counter

vii. The following components are to be provided with each circuit breaker:

1. With stored energy spring mechanism for motor charging and emergency manual operation.
2. Requisite tripping and closing coils, including security interlocks
3. With mechanical push buttons for closing and opening
4. With mechanical indicators for switch position and mechanism position
5. With mechanical counter
6. With shunt release OFF Y2

Technical Specification for 36kV GAS INSULATED SWITCHGEAR. Rev 00 - 10 -
7. With shunt release ON Y3
8. Detection of the switch positions is to be performed by wear and tear free proximity sensors.

vii. Control voltage for tripping, closing, relays and motor shall be 220V DC measured at the device terminals suitable for operation between 110% to 70%.

viii. The minimum number of normally open and normally closed auxiliary contacts on each circuit breaker. Auxiliary switch, additional to those required for control and interlocking, shall be as specified. The fitting of additional auxiliary relays to achieve the number of auxiliary contacts required will not be acceptable.

ix. Indicating devices shall be provided to clearly indicate whether a circuit-breaker is open or closed.

x. Each circuit-breaker shall be provided with an operation counter per mechanism to record the number of tripping operations performed.

xi. Testing certificates shall be provided with the switchgear to enable ascertaining of timing of the circuit breakers operations. All details of the test facilities/setup available to this respect shall be submitted with the tender.

xii. Vacuum circuit breaker shall be maintenance free:

1. No re-lubrication or adjustment
2. Vacuum tight for life.

xiii. The vacuum circuit breaker shall form a completely independent & interchangeable module so that in case of failure, the VCB can be replaced, in least time.

xiv. All circuit breakers shall be routine & type tested in accordance with IEC 62271-100.

5.0 ISOLATORS/EARTHING SWITCH:

a) Isolators with earthing switch shall have 3 positions closed: Open-Earthed with motor operated.
b) Isolators shall connect busbars/circuit breakers/LINE, if closed.
c) In the circuit breaker cubicles, the operation of both busbar and cable side isolators must be simultaneous, operated from the front part of the cubicle. This operation must be interlocked with the relevant circuit breaker and earthing switch.
d) Isolators shall also be fitted with accessories hereunder indicated:
   i. manual operating mechanism on the front part of cubicle
   ii. auxiliary contacts
   iii. electromechanical lock
   iv. mechanical indication of position for earthed position.
e) In cases of emergency, manual operation must be possible.
f) Detection of the switch positions is to be performed by wear and tear free proximity sensors.
g) The earthing position for all 3 phases must either be visible or directly detectable at the main contacts. Auxiliary switches on the operating mechanism are not permitted for this purpose.

6.0 INSTRUMENT TRANSFORMERS & PROTECTION SCHEME:-

6.1 CURRENT TRANSFORMERS

A) GENERAL:
Technical Specification for 36kV GAS INSULATED SWITCHGEAR. Rev 00

- 11 -
i. The current transformers and accessories shall conform to IEC: 60044-1 and other relevant standards except to the extent explicitly modified in the specification.

ii. The Principle parameters shall be as per clause 8.3.1.

B) RATIOS AND CHARACTERISTICS

The number, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with Table I – A, II – A & III – A. Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

C) RATING AND DIAGRAM PLATES

Rating and diagram plates shall be as specified in the IEC specification incorporating the PO No, Date and year of manufacture. The general knee point voltage formula and rated continuous thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

D) CONSTRUCTIONAL DETAILS:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of metal- enclosed type. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the Panel. The star/delta configuration and the inter connection will be done at the CT terminal block located in the Panel.

c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

d) The rated extended primary current shall be 125% at all ratios.

e) The instrument security factor at all ratios shall be as per table I – A, II – A, III – A for metering cores wherever aux CT’s/Reactors are allowed in the CT’s then all parameters specified shall have to be met treating auxiliary CT’s as an integral part of the CT’s. The aux CT’s/Reactors shall preferably be built in construction of the CT’s.

f) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the marshalling box.

g) Provisions shall be made for primary injection testing either within CT or outside.

h) Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

6.2 VOLTAGE TRANSFORMERS

A) GENERAL

The voltage transformers shall conform to IEC- 60044-2 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box. The Principle parameters shall be as per clause 6.3.2.

B) RATIOS AND CHARACTERISTICS

The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Table I – B.

C) RATING AND DIAGRAM PLATES

Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the PO No., Date and year of manufacture and including turns ratio, voltage ratio, burden, connection diagram, rated continuous and short time voltage factor etc.

D) SECONDARY TERMINALS, EARTHING AND FUSES/MCBs
The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

The transformer shall be able to sustain full line to line voltage without saturation of transformer.

E) CONSTRUCTIONAL DETAILS OF VOLTAGE TRANSFORMERS:

a) The voltage transformers shall be located in a separate bay module on the bus and will be connected phase to ground and shall be used for protection, metering and synchronization.

b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients.

c) Voltage transformer’s secondary shall be protected by HRC cartridge type fuses/MCBs for all the windings. In addition fuses/MCBs shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VT’s shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via the fuse/MCB.

d) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

e) The diagram for the interconnection of the VTs shall be provided inside the marshalling box.

6.3 PRINCIPLE PARAMETERS:

6.3.1 CURRENT TRANSFORMERS

<table>
<thead>
<tr>
<th>S. No</th>
<th>Particulars</th>
<th>33 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated voltage Un</td>
<td>36kV (rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>c)</td>
<td>System neutral earthing</td>
<td>Solidly Earthed</td>
</tr>
<tr>
<td>d)</td>
<td>Rated short time thermal current</td>
<td>31.5 kA for 1 second</td>
</tr>
<tr>
<td>e)</td>
<td>Rated dynamic current</td>
<td>65.75 kAp</td>
</tr>
<tr>
<td>f)</td>
<td>Rated insulation levels</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>1.2/50 micro second impulse voltage</td>
<td>±170 kVp</td>
</tr>
<tr>
<td>ii)</td>
<td>1 Minute power frequency withstand voltage</td>
<td>70 kV (rms)</td>
</tr>
<tr>
<td>g)</td>
<td>One minute power frequency</td>
<td>3.0 kV (rms)</td>
</tr>
<tr>
<td>h)</td>
<td>Maximum temperature rise over an ambient temperature of 50°C</td>
<td>As per IEC 60044-1</td>
</tr>
<tr>
<td>i)</td>
<td>Radio interference voltage at 1.1 Un/√3 and frequency range 0.5 to 2 MHz</td>
<td>&lt; 1000 Micro volts</td>
</tr>
<tr>
<td>j)</td>
<td>Rated continuous thermal current</td>
<td>125% on all taps</td>
</tr>
</tbody>
</table>

6.3.2 VOLTAGE TRANSFORMERS

<table>
<thead>
<tr>
<th>S. No</th>
<th>Particulars</th>
<th>33 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated voltage Un</td>
<td>36kV (rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
</tbody>
</table>
Annexure-VIII

Technical Specification for 36kV GAS INSULATED SWITCHGEAR. Rev 00

- 14 -

7.1 WIRING:

a) All wiring shall be of switch board type consisting of stranded / single annealed copper conductor insulated with polyvinyl chloride insulation suitable for 650 volts service and in accordance with IS : 694.

b) The wiring of the following circuits shall not be less than the size specified below:

CTs, PTs & CVTs circuits : 2.5 mm²
Control, alarm & supervision circuits etc. : 1.5 mm²

7.2 TERMINAL BOARDS, TEST BLOCKS & SPARE CONTACTS:

a) Terminal block connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the outgoing ends of the panel wiring and the corresponding tail ends of control cables. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. Provision shall be made on each pillar for holding 10% extra connectors.

b) The terminal blocks shall be suitable for 650 Volts service and for connection with both copper and aluminium wires.

c) Terminal boards shall be mounted in such a manner as to afford easy access to terminations and to enable ferrule numbers to be read without difficulty. Wire ends shall be so connected at the terminals that no wire terminal gets marked due to succeeding connections. Terminal
board rows shall be adequately spaced and shall not be less than 100 mm apart so as to permit convenient access to wires and terminations. Labels in the form of engraved plastic plates shall be provided on the fixed portion of terminal boards. No live metal parts shall be exposed at the back of terminal boards.

f) All auxiliary contact contacts of switchgear are required to be brought on T.B's and shall be indicated on the drawings.

7.3 FERRULES:
Wire No. shall be indicated on panel schematic and wiring diagrams and accordingly engraved ferrules with the same numbers and letters as indicated in the said diagrams shall be provided on the terminal ends of all wires for easy identification of circuits for inspection and maintenance. Ferrules shall be of strong & flexible insulating material with glossy finish to prevent adhesion. These shall be engraved and marked clearly and shall not be affected by dampness. Ferrule numbering shall be in accordance with IS: 375. The same ferrule number shall not be used on wires in different circuits on a panel. At those points of interconnection between the wiring carried for equipments of different suppliers where a change of number cannot be avoided double ferrules shall be provided on each wire with the appropriate connection diagram of the equipment.

7.4 SPACE HEATERS:
Tubular space heaters suitable for connection to the single phase 220 Volts AC supply complete with switches located at convenient positions shall be provided at the bottom of each panel to prevent condensation of moisture. The watt loss per unit surface of heater shall be low enough to keep surface temperature well below visible heat.

7.5 ILLUMINATION:
The panel shall be provided with 220/240 Volts AC interior lighting. The lamp shall be free from hand shadows. A door operated button switch shall be provided in each panel. Each panel shall be provided with one no. illumination lamp with door switch.

7.6 POWER SOCKET:
Single phase 240 volt AC, 5-Pin, 5/15A power socket with power on/off switch shall be provided in each panel.

7.7 SAFETY EARTHING:
Earthing of current free metallic parts or metallic bodies of the equipment mounted on the switch boards shall be done with bare copper conductor. Copper bus of size 25 mm x 6 mm extending through entire length of a panel board shall be provided. The earthing conductor shall be connected by Rose Courtney terminals and clamp junctions. The neutral point of star connected secondary windings of instrument transformers and one corner of the open delta connected LV side of potential transformer, if used shall be similarly earthed with the main earth bar of the switch board earthing system. Multiple earthing of any instrument transformer shall be avoided. An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

NOTE:- Earthing system of GIS Panels shall conform to the standards mentioned at Cl. No. 2.0
7.8 **NAME PLATE:**
An easily accessible engraved or painted panel name plate shall be provided inside each panel. It must include G.A. drawing No., purchase order No., Contractor’s reference No., name of S/Stn. as per purchase order and name of circuit. In addition to this, an engraved plate indicating the purchase order no. alongwith name of S/Stn. is required to be affixed on the panel at appropriate height so that it is readable while standing in front of the panel. These are required to be indicated on the G.A. drawings also. An engraved label indicating the purpose of all the relays & switches shall also be provided.

8.0 **CABLE TERMINATIONS:**
The design of the switchgear shall permit easy access for the installation and termination of PE or XLPE Power Cables. Size of Cable shall be as specified in Section Project. Cable Termination kit if specified in section Project shall be supplied along with GIS. Isolating link shall be provided in the cable compartment for easy testing of the cable. Access for primary current injection shall be provided in the GIS.

9.0 **INTERLOCKING FEATURES:**
In order to ensure proper operation and to prevent dangerous situations and maloperation, a series of interlocks must be provided to protect the operators and the switchgear itself. Fundamentally, the protection against maloperation is to be effected in the panel.

*Electromechanical or software based interlocking is acceptable.*

The following interlocking dependencies must be provided:
- Limit position blocking of the switching devices
- Interdependence of disconnector and earthing switch in the same panel
- Interdependence of the disconnector and the circuit breaker in the same panel
- Interdependence of the circuit breaker and the earthing switch in the same panel
- Dependence of the disconnector on the bus coupler circuit breaker and vice versa.

10.0 **SWITCHBOARD/PANEL COMPLETION ACCESSORIES:**
The following standard accessories shall be also included for completion of the switchboard configuration for this project:

i. End panels
ii. Lifting eyebolts
iii. Series of leavers and special tools
iv. Paint for touching up (1 kg tin)
v. Catalogues and drawings
vi. Instruction booklets

The contractor shall supply any other standard accessory as required to complete the configuration and satisfactory operation of the switchboard.

11.0 **TESTS:**
All tests shall be carried out according to relevant IEC standards.

11.1 **TYPE TESTS**
The metal-enclosed switchgear is to be type tested at a recognized and internationally well-reputed test laboratory. Type test certificates shall be available for verification as evidence of successful completion of type tests. The switchgear furnished under this specification shall be fully tested and documented by certified production test reports in accordance with IEC 62271-200.

11.2 ROUTINE TESTS
Tests shall be carried out according to IEC requirements. The following minimum tests apply:
- Wiring and function tests
- Equipment verification tests
- Low voltage circuit insulation test
- High voltage power frequency test

11.3 FACTORY INSPECTION TESTS
Notification for factory tests along with list of proposed tests shall be submitted as required.

11.4 SITE TESTS
The site tests shall include the following:
- Power frequency withstand test (at 80% of the rated power frequency withstand voltage)
- Insulation resistance
- Functional test of the fully installed and wired equipment delivered.
**TABLE I-A**

COREWISE DETAILS OF 36kV TRANSFORMER INCOMER CT FOR 220/33KV T/F WITH 31.5KA STC

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Application</th>
<th>Current Ratio (A)</th>
<th>Output Burden (VA)</th>
<th>Accuracy class as per IEC</th>
<th>Formula for minimum knee-point voltage at CT Secondary resistance at 75°C at 2000A tap (Volt)</th>
<th>Maximum Exciting Current (mA)</th>
<th>A.L.F./ ISF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DIFFERENTIAL PROTECTION</td>
<td>2000-1000/1</td>
<td>-</td>
<td>PS</td>
<td>40 (RCT+2)</td>
<td>30AT V_k/4</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>OVER CURRENT &amp; EARTH FAULT PROT.</td>
<td>2000-1000/1</td>
<td>-</td>
<td>PS</td>
<td>40 (RCT+2)</td>
<td>30AT V_k/4</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>MAIN METERING</td>
<td>2000-1000/1</td>
<td>10</td>
<td>0.2S</td>
<td>-</td>
<td>-</td>
<td>For ratio 1000/1 ISF&lt;5, For ratio 2000/1 ISF&lt;10.</td>
</tr>
</tbody>
</table>

**TABLE II-A**

COREWISE DETAILS OF 36kV LINE CT WITH 31.5KA STC

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Application</th>
<th>Current Ratio (A)</th>
<th>Output Burden (VA)</th>
<th>Accuracy class as per IEC</th>
<th>Formula for minimum knee-point voltage at CT Secondary resistance at 75°C at 2000A tap (Volt)</th>
<th>Maximum Exciting Current (mA)</th>
<th>A.L.F./ ISF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DISTANCE/DIFFERENTIAL PROTECTION</td>
<td>800-400/1</td>
<td>-</td>
<td>PS</td>
<td>40 (RCT+2)</td>
<td>30AT V_k/4</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>OVER CURRENT &amp; EARTH FAULT PROT.</td>
<td>800-400/1</td>
<td>-</td>
<td>PS</td>
<td>40 (RCT+2)</td>
<td>30AT V_k/4</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>MAIN METERING</td>
<td>800-400/1</td>
<td>10</td>
<td>0.2S</td>
<td>-</td>
<td>-</td>
<td>For ratio 400/1 ISF&lt;5, For ratio 800/1 ISF&lt;10.</td>
</tr>
</tbody>
</table>
### TABLE III-A

**COREWISE DETAILS OF 36kV BUS COUPLER CT FOR 220/33KV WITH 35.1 KA STC**

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Application</th>
<th>Current Ratio (A)</th>
<th>Accuracy class as per IEC</th>
<th>Output Burden (VA)</th>
<th>Accuracy class as per IEC</th>
<th>A.L.F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OVER CURRENT &amp; EARTH FAULT PROTECTION</td>
<td>2000-1000/1</td>
<td>PS</td>
<td>-</td>
<td>40 (RCT+2)</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>MAIN METERING</td>
<td>2000-1000/1</td>
<td>10</td>
<td>0.2S</td>
<td>For ratio 400/1 ISF&lt;5. For ratio 800/1 ISF&lt;10.</td>
<td></td>
</tr>
</tbody>
</table>
## TABLE I-B

**COREWISE DETAILS OF 36kV POTENTIAL TRANSFORMER (PT) OF 2 CORES.**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Requirement</th>
<th>Particulars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated Primary voltage</td>
<td>36/√3kV</td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
<td>Single phase</td>
</tr>
<tr>
<td>3.</td>
<td>No. of Secondaries</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Rated voltage factor</td>
<td>1.2 continuous &amp; 1.5 for 30 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Rated voltage (volts)</td>
<td>Secondary-I 110/√3</td>
</tr>
<tr>
<td>6.</td>
<td>Application</td>
<td>Main metering Protection Protection</td>
</tr>
<tr>
<td>7.</td>
<td>Accuracy</td>
<td>0.2S 1/3P 1/3P</td>
</tr>
<tr>
<td>8.</td>
<td>Output burden (VA)</td>
<td>10 50 50</td>
</tr>
<tr>
<td>9.</td>
<td>Percentage voltage error &amp; phase displacement (minutes) for respective specified accuracy classes.</td>
<td>As per ISS/IEC</td>
</tr>
</tbody>
</table>
ANNEXURE– IX

Technical parameter for 72.5 kV Equipment’s & 33 kV NCT

A. Technical Parameters for 72.5 kV Current Transformers

1. Rated Primary current 50 A
2. Rated extended current 120%
3. Rated short time current 25 kA for 3 sec.
4. Rated dynamic current 63 kA
5. Maximum temperature rise over design ambient temperature As per IEC-60044-1
6. One minute power frequency withstand voltage sec. terminal & earth 5 kV (rms)
7. Number of terminals All terminals of control circuits are to be wired upto marshalling box plus 20% spare terminals evenly distributed on all TBs.
8. Type of insulation Class A

Current transformers shall also comply with requirements of technical specification & below table.

REQUIREMENTS FOR 72.5 kV CURRENT TRANSFORMER

<table>
<thead>
<tr>
<th>No. of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current Ratio</th>
<th>Output burden (VA)</th>
<th>Accuracy class &amp; AL as per IEC 44-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>O/C &amp; E/F</td>
<td>50/1</td>
<td>10</td>
<td>5P10</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Metering</td>
<td>50/1</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>

B. TECHNICAL PARAMETERS FOR 72.5 kV VOLTAGE TRANSFORMERS

1. System Fault level 25kA for 3 second
2. Standard reference range of frequencies for which the accuracies are valid 96% to 102% for protection and 99.5 to 101% for measurement
3. One minute power frequency withstand voltage for secondary winding 3kV (rms)
4. Maximum temperature rise over design ambient As per IEC:60044-2 or IEC:60044-5
temperature

5  Number of terminals in control cabinet  All terminals of control circuits are wired up to marshalling box plus 20% spare terminals evenly distributed on all TBs.

Voltage Transformers shall also comply with requirements of technical specification & below table.

### Requirements of 72.5 kV Voltage Transformer

<table>
<thead>
<tr>
<th>S.N.o.</th>
<th>PARTICULAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated primary voltage (kV rms) 72.5</td>
</tr>
<tr>
<td>2.</td>
<td>Type Single phase Electro-magnetic or Capacitive VT</td>
</tr>
<tr>
<td>3.</td>
<td>No. of secondaries 2</td>
</tr>
<tr>
<td>4.</td>
<td>Rated Voltage Factor 1.2 continuous 1.5 – 30 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Phase angle error + 20 minutes (For metering core)</td>
</tr>
<tr>
<td>6.</td>
<td>Voltage ratio 33/√3 / 0.11/√3 33/√3 / 0.11/√3</td>
</tr>
<tr>
<td>7.</td>
<td>Application Protection Metering</td>
</tr>
<tr>
<td>8.</td>
<td>Accuracy 3P 0.5</td>
</tr>
<tr>
<td>9.</td>
<td>Output Burden (VA) (minimum) 10 10</td>
</tr>
</tbody>
</table>

### C. Technical Parameters for 72.5 kV Circuit Breaker

<p>| 1.     | Rated continuous current (A) at design ambient temperature of 50oC 1250 |
| 2.     | Rated short circuit current breaking capacity at rated voltage 25kA with percentage DC component as per IEC 62271-100 corresponding to minimum opening time under operating conditions specified. |
| 3.     | Symmetrical interrupting capability kA (rms) 25 |
| 4.     | Rated short circuit making current kA (peak) 63 |
| 5.     | Short time current carrying capability for three second kA (rms) 25 |
| 6.     | Rated line/cable charging interrupting current at 90o leading power factor angle (A rms) As per IEC |</p>
<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of $U_0/3$ and 1.4 as per IEC 62271-100)</td>
<td>As per IEC</td>
</tr>
<tr>
<td>7. Maximum allowable switching over voltage under any switching condition</td>
<td>Less than 80</td>
</tr>
<tr>
<td>8. Total break time as per Clause 3.0 of Technical specification (ms)</td>
<td>Less than 75</td>
</tr>
<tr>
<td>9. Rated break time as per IEC (ms)</td>
<td>Not more than 200</td>
</tr>
<tr>
<td>10. Total closing time (ms)</td>
<td></td>
</tr>
<tr>
<td>11. Rated operating duty</td>
<td>O-0.3S-CO-3min-CO Cycle</td>
</tr>
<tr>
<td>12. Operating mechanism</td>
<td>Spring</td>
</tr>
<tr>
<td>13. Trip coil and closing coil voltage</td>
<td>220V DC with variation as specified in clause 8.2.5 of Tech. spec.</td>
</tr>
<tr>
<td>14. Auxiliary contacts</td>
<td>Besides requirement of Technical specification, the contractor shall wire up 2 NO + 2 NC contacts for future use of Employer</td>
</tr>
<tr>
<td>15. Noise level at base and up to 50 m distance from base of breaker</td>
<td>140 dB (Max.)</td>
</tr>
<tr>
<td>16. Rated terminal load</td>
<td>As per IEC or as per the value calculated in section - GTR of Tech. Spec., whichever is higher.</td>
</tr>
<tr>
<td>17. Temperature rise over the design ambient temperature</td>
<td>As per IEC 60694</td>
</tr>
<tr>
<td>18. First pole to clear factor</td>
<td>1.5</td>
</tr>
<tr>
<td>19. No. of terminals in common control cabinet</td>
<td>All contacts &amp; control circuits to be wired out up to common control cabinet plus 10 Terminals exclusively for Employer’s use.</td>
</tr>
</tbody>
</table>

72.5 kV CB shall also comply with requirements of technical specification.

**D. Technical Parameters for 72.5 kV Isolator**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rated voltage</td>
<td>72.5 kV</td>
</tr>
<tr>
<td>2. Rated current</td>
<td>400 A</td>
</tr>
<tr>
<td>3. Standards</td>
<td>IEC 62271-102</td>
</tr>
<tr>
<td>4. Rated short time withstand (in KA)</td>
<td>25KA for 3 sec.</td>
</tr>
<tr>
<td>5. Operating drive</td>
<td>AC Motor operated (isol)</td>
</tr>
<tr>
<td></td>
<td>Manual operated (E/S)</td>
</tr>
<tr>
<td>6. Type</td>
<td>Double break Isolator without E/S, 3 pole, outdoor, Gang operated</td>
</tr>
<tr>
<td>7. Interlock</td>
<td>Electrical interlock with circuit breaker. Mechanical castle key interlock to be provided between electrical and manual operation.</td>
</tr>
<tr>
<td>8. Construction details</td>
<td>All ferrous parts to be galvanized</td>
</tr>
</tbody>
</table>
72.5 kV Isolator shall also comply with requirements of technical specification.

E. **Technical Parameters of 33 kV Neutral Current Transformers (NCT)**

33 kV Neutral Current Transformer (NCT) shall also comply with the requirements of technical specification & below Table

<table>
<thead>
<tr>
<th>Description</th>
<th>Current Transformer Parameters (Transformer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORE 1</td>
<td>Ratio 1000/1</td>
</tr>
<tr>
<td>CORE 1</td>
<td>Minimum knee point voltage or burden and accuracy class: 600V, TPS</td>
</tr>
<tr>
<td>CORE 1</td>
<td>Maximum CT Secondary Resistance: 1.5 Ohm</td>
</tr>
<tr>
<td>CORE 1</td>
<td>Application: Restricted Earth Fault</td>
</tr>
<tr>
<td>CORE 1</td>
<td>Maximum magnetization current (at knee point voltage): 100 mA</td>
</tr>
</tbody>
</table>
Technical specifications for “Transformer Oil Filtration Plant”

1.1 Performance Requirement

1.1.1 The Ultra High Vacuum type oil treatment plant of capacity of 10KLPH / 6KLPH (Kilo litre per hour) shall be mobile and shall be suitable for treatment of new oil and reconditioning of used oil in EHV class transformer, shunt reactor and other oil filled equipment in order to achieve properties of treated oil within specified limits at the rated capacity.

1.1.2 The plant shall be capable of treatment of new oil (as per IEC 296/IS:335) and reconditioning of used oil (as per IS:1865/IEC:422 for oil in-service) at rated capacity on single pass basis as follows:

(i) Removal of moisture from 100 ppm to 3 ppm (max.)
(ii) Removal of dissolved gas content from 10% by Vol. to 0.1% by vol.
(iii) Improvement of dielectric strength break down voltage from 20 KV to 70 KV (min).
(iv) Vacuum level of degassing chamber at rated flow and at final stage :- not more than 0.15 torr (0.2 m bar) max.
(Degassing chambers of different degree of vacuum should have sufficient surface areas to achieve the final parameters. A detailed justification as to how end parameters shall be met with detailed calculations and test reports in support of the same shall be submitted along with the offer.
(v) Filtering capacity: Max. particle size less than 0.5 micron in the filtered oil.
(vi) Processing temperature :- 40º C to 60ºC (Maximum allowed temp. in oil to prevent oxidation (when oil is at atmospheric pressure) :- 60ºC)

1.1.3 Bidder is to furnish along with the bid detailed calculation to establish the sizing and capability of the vacuum pumping system with respect to moisture and gas removal as above.

1.1.4 Bidder is to submit along with the bid test reports, test methodology to prove the capability of the plant offered.

1.1.5 The plant shall also have two independent vacuum pumping systems one for evacuating the transformer for vacuum filling of oil in transformer and the other for degassing chamber. The blank off vacuum of each pumping system shall be 10⁻³ torr or less.

1.1.6 The plant shall be provided with control and indication panel with full automation.

1.1.7 The plant shall be fitted with hoses for connection of oil lines and vacuum lines to transformers and reactors. Hoses shall have leakage rate of 10⁻² torr-ltr/sec. (max.)

1.1.8 The Ultra High Vacuum Type oil purification plant shall be complete with oil pumps for drawing oil for transformers and reactors, oil heater (max. heating rate = 2.0W/cm²) of adequate rating, suitable filter or centrifuge as required to ensure oil quality, degasifier complete with vacuum pumps, oil extraction pump etc. of adequate capacity such that throughout from the purification plant is of guaranteed purity.

1.1.9 The plant shall also be suitable for cleaning and degassing of the oil stored in the storage tanks.

1.1.10 All equipments required as above shall be mounted on a tow-able road worthy trailer unit with 4 nos. pneumatic tyres. The equipment shall be suitable for outdoor use.

1.2 Design & Construction
The features and construction details of each 10KLPH / 6KLPH mobile outdoor type oil filtration & purification plant shall be in accordance with the requirements stated hereunder.

1.2.1 **Oil Pump** (Inlet Side)

1.2.1.1 Two (2) nos. electrically driven oil pumps with one (1) working and one (1) standby shall be provided. Selection switch is to be provided for selection of either of pumps. The pumps shall be single stage positive displacement gear type. Suitable mechanical seals shall be provided to ensure vacuum tightness. A built-in pressure relief valve to re-circulate the oil to suction side in case of accidental pressure rise shall be provided. Suction lift of the pump shall be at least 5 meters of transformer oil at atmospheric pressure & temperature. A separate by pass valve is provided across the gear pump so that the flow rate through the filter can be adjusted as required. The pump should be controlled by frequency drive. This should help to set the flow rate of filter plant from 4000 – 6000 LPH for 6KLPH machine and from 8000-10000 LPH for 10KLPH machine.

1.2.1.2 The pumps shall be provided with an interlock with delay such that if there is no oil flow of 30 sec. through the heater, the pump shall trip automatically and also if the pump is not operating the heater will not be energized.

1.2.2 **Magnetic Strainer**

The plant shall be provided with suitable magnetic strainer with wire mesh to filter all particles of sizes above 0.5 mm and all magnetic particles. The strainer shall be installed at the suction of the oil pump described above.

1.2.3 **Heater**

a) An oil heater for heating up inlet oil shall be provided at the discharge side of the oil pump.

b) The oil heater vessel shall be of mild steel welded construction & insulated with glass/mineral wool.

c) The vessel shall be constructed for ultra high vacuum & pressure application.

d) Electric heater shall be provided inside the heater vessel to heat up oil from lowest ambient temperature to temperature required for filtration/degasification operation in single pass. The heater shall also be rated for heating the inlet oil from lowest ambient temperature at 70°C in single pass during filling up of transformers. Two separate temperature settings with thermostatic controllers shall be provided for this purpose.

e) The heating shall be indirect type and specific heat load shall not exceed 2.0 watt/cm² in order to avoid local overheating.

f) The total heating capacity shall be divided into three independent thermostatically controlled heating stages evenly balancing the three phases of power supply. The control switches and knobs shall be housed on a control panel.

g) An additional preset temper proof safety thermostat set at the highest temperature shall be provided on the heater to put off the heater and give audio and visual alarm to take care of accidental overheating.
h) The heater body shall be so designed as to allow replacement of heating elements without draining of oil. Suitable pressure relief valve, vent and drain valves & two (2) dial type temperature gauges at inlet & outlet of heater shall be provided.

1.2.4 Filter
a) Cartridge filter as may be required to ensure maximum particle size to less than 0.5 micron in the filtered oil shall be provided.

b) The filter body shall be fabricated of mild steel & designed for leak tightness at full vacuum & high pressures. The oil will flow from dirty oil chamber to clean oil chamber through filter elements.

c) Cartridge type element used shall be suitable for transformer oil in service and submicronic filtration, the media shall be non hygroscopic and of high dirt holding capacity.

d) The filter elements shall be easily removable for replacement when required. Compound gauge to indicate pressure across the filter, vent and drain with valves & other necessary accessories shall be mounted on the filter for each operation.

1.2.5 External Solenoid Operated valves

Two valves should be provided at the inlet and outlet of the plant. The moment inlet and outlet pumps are switched on these valves open thus making way for oil to pass. In case of power failure, oil from the transformer will not enter the plant and vacuum system.

1.2.6 Degassing Chamber

a) The degassing chamber shall be of welded construction and shall be suitable for operation under full vacuum. The fill of rasching rings & trays for distribution shall be designed for efficient distribution of oil over large areas. Incoming transformer oil should be spread over these rings in the form of film and over a longer surface area, thus achieving better degassing and dehumidification.

b) The degassing chamber shall be multistage (minimum 02 stages) type suitable for ensuring the desired oil properties. Arrangement for condensing back lighter fraction (aromatics) of the insulating oil into the system shall be provided.

c) The degassing channels shall have adequate height to allow long enough free fall for complete degassing. Design shall be such as to minimize foam formation.

d) The degassing chambers shall be provided with suitable level monitor for oil or foam level in the chamber and shall trip the inlet gear pump when the level rises above the designed maximum level in order to prevent foam/oil to enter the vacuum pumping system. The oil inlet pump starts again automatically once the oil level in the degassing chamber falls below the preset oil level.

e) Necessary illuminated sight glass shall be provided through which oil flow through the degasser can be viewed clearly.

f) The degasser shall be provided with vacuum gauges, vacuum breaking valves, main and auxiliary vacuum connections and other necessary accessories.
1.2.7 Vacuum Pumping System

a) The pump shall be provided with a suitable vacuum pumping system for creating adequate high vacuum in the degassing chambers. The pumping system shall consist of suitable combination of Roots Blowers and Rotary vane vacuum pumps with inter-stage condensing units.

b) The roots blowers shall be of reputed make. Suitable built in labyrinth packing system, slinger rings, oil return chambers shall be provided between bearings and working chambers to prevent penetration of lubricating oil to the working chamber. The pumps motor shall be dynamically balanced. The pumps shall be suitable for starting evacuation from atmospheric pressure and shall be applied with necessary overflow valve.

c) The rotary vane vacuum pumps shall be installed after the roots blower. An automatic by pass valve across the roots blower shall permit operation of rotary vane pump alone to operate when so required. The rotary vane pumps are provided with gas ballast valve to prevent contamination of vacuum pump oil with moisture. The vacuum pump shall also be provided with suitable non-return valve device such that in the event of power failure the vacuum in the degassing chamber shall be maintained and the vacuum pump oil is not sucked back into the degassing chamber. A high vacuum safety valve (piston type) to prevent back streaming of oil and air intrusion shall be provided. The pump motors shall be having return stop device.

d) Necessary water cooled condensing units to condense the light faction (aromatics) and return the same to the transformer oil shall be provided to reduce the loss of aromatics. Condensing units shall also be suitable for operation with broken ice for remote location operation where cooling water connection is not available.

1.2.8 Vacuum Pumping system for TRANSFORMER Evacuation

An independent vacuum pumping system shall be provided for evacuating the transformer for oil filling. The vacuum level required for transformer evacuation for oil transfer is about 0.76 torr (1 m bar) for transformer oil heated to 70-80°C. The pumping system shall be identical to that of the degassing vacuum system. The capacity shall be adequate for evacuation of:

a) 60KL Tank in one hour from 1 atm to 1mbar. (For 6KLPH Machine)

b) 90KL Tank in one hour from 1 atm to 1mbar. (For 10KLPH machine)

The vacuum systems for degasser and transformer evacuation shall be inter connected in such a way that it shall be possible to use either or both the systems for any of the purpose. A reinforced hose of 10 mts. length should be provided. The hoses must be for vacuum leakage rate of $10^{-2}$ torr-litre/sec.

1.2.9 Oil Extraction Pump

Suitable pumping system shall be provided for extracting oil from degasser under vacuum and supplying to transformer/reactor etc., at
discharge pressure of 1.5 kg/cm² at the outlet hose nozzle of the plant, the pump shall be either glandless centrifugal type with canned motors or a combination of gear pump and centrifugal pump with mechanical seals suitable for extracting oil from high vacuum degassing chamber. The oil extraction pump shall be located at a suitable level below the degasser chamber so as to ensure adequate suction head for the pump. The pump shall be supplied with double check valve assembly and solenoid operated non return valve. In order to stop reverse flow of oil in case of power failure, the pumping system shall preferably be self priming type alternatively priming device with safety interlock to protect pump against dry running shall be provided. Sampling valves shall be provided at the discharge of extraction pump for testing of oil properties. A recirculation line with valves shall be provided to recirculate a part of the purified oil to the inlet point if necessary during operation. The pump should be controlled by frequency drive. This should help to set the flow rate of filter pant from 4000 – 6000 LPH for 6KLPH machine and from 8000-10000 LPH for 10KLPH machine

1.2.10 Hoses For Transformer Oil, Vacuum, Air And Water

a) Separate reinforced rubber hoses shall be provided for each operation for oil suction, oil discharge, transformer vacuum connection and cooling water supply and return. The hoses shall be at least 15 meter long each and shall be complete with hose quick connect couplers for connection to installations under operation.

b) Hose pipes for oil service shall be suitable for transformer oil application upto temperature of 100° C, full vacuum and pressure upto 2.5 kg/cm². All oil hoses shall be built up around an earthed core or have built in earthed conductor to avoid static electricity accumulation. Inlet and outlet nozzles of purification plant and corresponding hoses shall be of 50 NB/40 NB size respectively in order to avoid error in connecting.

c) Vacuum hoses shall be of braided nitrile rubber suitable for full vacuum without collapsing and kinking. The vacuum hoses shall be transparent construction such that accidental oil flow can be easily detected.

1.2.11 Oil sampling valve: Suitable valve shall be provided for taking sample during filtration.

1.2.12 Material of construction and painting

a) Oil heater, filter vessel, degasser shall be of mild steel construction. The internal and external surfaces including oil heater, filter vessel, degasifier and structural steel work to be painted shall be shot or sand blasted to remove all rust and scale of foreign adhering matter or grease. All steel surface in contact with insulating oil shall be painted with two coats of heat resistant oil insoluble, insulating varnish.

b) All internal paints steel surfaces shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of a color distinct from primary and final two coats of glossy oil and weather resisting paint.
c) All paints shall be carefully selected to withstand heat and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

d) Bolts & Nuts: All bolts and nuts exposed to weather shall be hot dip galvanized/cadmium plated and passivated /zinc plated and passivated.

e) Material of construction for vacuum pumps air compressor, air drying plant, air receiver shall be steel of suitable grade.

f) All piping and equipment carrying transformer oil shall be insulated with glass wool/mineral wool insulation.

1.3 Instrumentation and Control

1.3.1 Following minimum instruments shall be provided on the oil purification plant:

a) Compound gauge at oil pump discharge
b) Compound gauge at filter inlet.
c) Compound Gauge at filter outlet
d) Pressure Gauge at discharge pump outlet
e) Pressure Gauge at degasifier
f) Vacuum Gauge at transformer evacuation line
g) Vacuum Gauge in between roots, vacuum pump and rotary vane vacuum pump.
h) Panel mounted vacuum indicators at degasser
i) Panel mounted vacuum indicators at transformer evacuating line.
j) Separate fine vacuum gauge for measurement of vacuum for transformer evacuation system and oil line degassing chamber evacuation system should be provided. This vacuum gauge should be electronic type having range from 0.01 torr to 20 torr and should be of any of these reputed manufacturers' (Wika/ Hasting/ Edwards) make.

k) Oil Filtration Machine should be fitted with on-line moisture in oil-PPM indicator.
l) Sight glass at degassifier
m) Temperature indicator cum controller at heater inlet
n) Temperature indicator cum controller at heater outlet
o) Voltmeter
p) Oil flow meter (Positive displacement type)
q) Ammeter

1.3.2 Control Panel:

A centralized electrical panel with auxiliary step down transformer, contractors, back up protection fuses, indicating lamps etc. to be provided with following minimum audio and visual alarms:

a) High temperature at heater outlet
b) High differential pressure across filters
c) Oil pump trip
d) Vacuum pump trip
e) Loss of vacuum in degassing chamber
f) Loss of vacuum in transformer evacuation line
g) No oil flow through heater
h) High oil level in degasser.

All controls and annunciation equipment should be suitable for 240 V AC.
1.3.3 Suitable interlock as described against each equipment shall be provided for safe and trouble free operation.

1.3.4 All instruments, control hardware and alarms shall be mounted on a suitable control panel. A mimic diagram with indication lamps showing on-off status of various equipments shall be provided on the control panel.

1.3.5 The plant shall be fully equipped with adequate instrumentation having provision of manual operation, if required. All necessary control and indicating panel shall be provided.

1.3.6 It shall be possible to use the oil transfer pump for the purpose of loading oil to transformers or reactors from tankers and vice versa by by-passing to purification plant, if required.

1.3.7 There shall be independent vacuum pump for creating and holding the transformer/ reactor winding under vacuum for vacuum drying and filling of winding when required. The vacuum pump shall have capacity to develop and maintain adequate vacuum in the oil space of the 60KL tank within 1 hour time.

1.4 Electrical System:

1.4.1 The plant shall receive 415V, 3 phase, 50 Hz, 4 wire power supply through flexible cable in the distribution panel located on the plant. The incomer of the distribution panel shall be switch fuse unit.

1.4.2 One length of 50 meters of core 1100V grade flexible cable with crimped lugs at one end shall be provided for connection of the unit to the mains. The length of the cable will be covered in a suitable cable drum.

1.4.3 Provision for earthing the plant at the operating locations with earthing terminals for safety shall be provided.

1.4.4 The plant shall be suitably illuminated and ventilated for comfort of operator.

1.5 Capacity Demonstration: The supplier has to submit the detailed calculations in support of meeting the desired vacuuming capacity in prescribed time along with their technical offer. The capacity calculations submitted by the supplier shall be evaluated as per below mentioned method:

\[ \text{Pumping Down Time (PDT)} = \frac{V}{S} \ln \left(\frac{P_1}{P_2}\right) \]

\[ \text{PDT} = 1.2 \times (\text{PDT1} + \text{PDT2}) \] ; Considering 1.2 as service factor

\[ \text{PDT1: } V = \text{Volume of Tank to be evacuated (90KL or 60KL)}, \]
\[ S = \text{Capacity of Vacuum pump in LPM, } P_1 = 760\text{mm of Hg, } P_2 = 50\text{ mm of Hg} \]

\[ \text{PDT2: } V = \text{Volume of Tank to be evacuated (90KL or 60KL)}, \]
\[ S = \text{Capacity of Roots pump in LPM, } P_1 = 50\text{ mm of Hg, } P_2 = 0.76\text{ mm of Hg} \]

If the supplier offers the capacity of vacuum pump and roots pump different than the capacity derived from above mentioned method, it has to demonstrate the machine at his Works for required capacity by achieving desired vacuum within prescribed time and this will be the part of technical evaluation i.e. pre-award demonstration of vacuuming capacity has to be arranged by supplier within 45 days of intimation by NEA without any financial implication to NEA.

The supplier, who offers the vacuuming capacity in line with the above method, shall have to demonstrate the machine (Post-Award) at his Works for required capacity by achieving desired vacuum within prescribed time.
The tank required for the demonstration at his Works is to be arranged by the supplier. The supplier who has already successfully demonstrated the desired vacuuming capacity in the region needs not to repeat again.

1.6 **Guarantee**: Min 01 year from the date of successful & complete commissioning at NEA sub-station. All the materials, including accessories, cables, components etc. are to be covered under warranty/guaranty period. If any component of the plant needs to be shifted to supplier’s works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, transportation of component/plant for repair at works.

1.7 **Commissioning, handing over the Instrument**: Successful bidder will have to commission the plant to the satisfaction of NEA. The equipment failed during the demo shall be rejected and no repairs are allowed.

1.8 **Training**: Supplier shall have to ensure that the plant is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to NEA engineers.
Annexure-XI

Specification of Line Current Differential Protection

1. Feeder Protection current differential relay with the following protection functions shall has to be provided under present scope:

   i. High speed numerical current differential protection feeder protection suitable to work through directly connected fiber optics.
   
   ii. The relay shall incorporate inter-tripping, VT Supervision functions and heavy duty contacts for tripping of the feeder circuit breaker as well as provide all flagging, alarms etc.
   
   iii. The protection relay should be compatible with remote end in all respect i.e. relay, CT, communication etc. Any interface equipment required also should be included.
   
   iv. Where the main relay does not have the teleprotection communication capability to work over directly connected fiber optic cables, in cases of long circuits, suitable amplifiers or other terminal equipment shall be provided at both the substations.

2. The detailed specification of current differential relay is as under:

The feeder Differential Current Protection shall comprise a well-proven high-speed phase segregated numerical current differential protection scheme, which shall be designed for the selective protection of the EHV network.

The current differential protection scheme shall comprise two relays, one at each end of the feeder. All related interfacing relays and wirings required for the scheme shall be included.

The bidder shall coordinate the requirements of the current differential relay with the communication system in order to ensure compatibility between the two systems.

The feeder differential current protection scheme to be provided shall have as a minimum the following main features:

1) Shall be a unit system of protection with back up features. The line differential relays for 400 kV feeders shall have distance back up function capable of being selected to function in parallel with the differential protection or activate automatically when the differential relay is out of service.

2) Shall have built signaling modules for communication with the remote end relay either via direct optical fiber cables or through multiplexers.

3) Shall have high-speed fault detection capability with typical relay operation time of less than 30 ms for 400kV faults.

4) Shall have high sensitivity for all types of faults.

5) Shall detect and clear faults along the whole length of the feeder within the specified operating time when the remote end breaker is open or there is a weak in feed.
6) Shall remain stable for fault on a parallel feeder under subsequent current reversal in the healthy feeder due to slow opening of one of the faulty feeder's circuit breakers.

7) Shall not be affected by heavy load transfer, power swings, CT saturation, distorted primary currents and voltages, VT fuse failure, line charging currents external switching, arc or tower footing resistance, sudden power reversal, zero sequence mutual coupling, fault resistance and out of phase source at the two line terminals producing misleading apparent fault reactance, power frequency variations, collapse of voltage on the faulted phase(s), etc.

8) Shall have low burdens/low requirements on the CT's and VT's.

9) The line differential device address shall be settable and shall be suitable to set at least 99 different feeders.

10) Shall have features to clear close in faults at high speed in the event of failure of signaling channel.

11) Shall be complete with all test devices required to test the relay's set values.

12) Shall have features to test at one end all the functions associated with the protection, without the presence of personnel at the remote end.

13) Shall have micro-processor based tripping logic

14) Shall have features to block relay in case of signaling channel failure or remote relay out of service / block or setting mismatch or dc failure etc., to avoid inadvertent tripping and shall produce alarm during blocking.

15) Shall have inter-tripping compliant with IEC60834-1 and IEC60834–2 respectively for signaling as appropriate.

16) CT supervision / VT Supervision shall be configured to initiate alarm locally and to sub-station automation system or event recorder as per requirement.

17) Shall have single pole/three pole tripping feature.

18) Shall have built-in SOTF logic feature.

19) Shall have features to block auto-reclose internally / externally at local end and facility to send blocking signals to remote end relay internally (through FO communication channels) during SOTF trips.

20) Shall have facility to configure signal transferred between local and remote end relays in the internal event recorder and disturbance recorder.

21) Shall have configurable time delayed thermal protection element.

22) The distance backup function in Line current differential relay shall have at least two distance backup protection elements.

The bidder shall also provide the following details:

1) Performance of relay under ct saturation during through faults.
2) Performance of relay under conditions of CT saturation for in zone faults.
3) Performance of relay during transient (jitter) and permanent changes in signaling propagation delays.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Particulars</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>FOREWORD</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>GENERAL REQUIREMENT</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>STANDARDS</td>
<td>1</td>
</tr>
<tr>
<td>4.0</td>
<td>SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED</td>
<td>2</td>
</tr>
<tr>
<td>5.0</td>
<td>ENGINEERING DATA AND DRAWINGS</td>
<td>8</td>
</tr>
<tr>
<td>6.0</td>
<td>MATERIAL/ WORKMANSHIP</td>
<td>10</td>
</tr>
<tr>
<td>7.0</td>
<td>DESIGN IMPROVEMENTS / COORDINATION</td>
<td>12</td>
</tr>
<tr>
<td>8.0</td>
<td>QUALITY ASSURANCE PROGRAMME</td>
<td>13</td>
</tr>
<tr>
<td>9.0</td>
<td>TYPE TESTING, INSPECTION, TESTING &amp; INSPECTION CERTIFICATE</td>
<td>14</td>
</tr>
<tr>
<td>10.0</td>
<td>TESTS</td>
<td>16</td>
</tr>
<tr>
<td>11.0</td>
<td>PACKAGING &amp; PROTECTION</td>
<td>16</td>
</tr>
<tr>
<td>12.0</td>
<td>FINISHING OF METAL SURFACES</td>
<td>16</td>
</tr>
<tr>
<td>13.0</td>
<td>HANDLING, STORING AND INSTALLATION</td>
<td>19</td>
</tr>
<tr>
<td>14.0</td>
<td>TOOLS AND TACKLES</td>
<td>20</td>
</tr>
<tr>
<td>15.0</td>
<td>AUXILIARY SUPPLY</td>
<td>20</td>
</tr>
<tr>
<td>16.0</td>
<td>SUPPORT STRUCTURE</td>
<td>21</td>
</tr>
<tr>
<td>17.0</td>
<td>CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS</td>
<td>21</td>
</tr>
<tr>
<td>18.0</td>
<td>CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES &amp; MARSHALLING BOXES FOR OUTDOOR EQUIPMENT</td>
<td>22</td>
</tr>
<tr>
<td>19.0</td>
<td>Void.</td>
<td>24</td>
</tr>
<tr>
<td>20.0</td>
<td>TERMINAL BLOCKS AND WIRING</td>
<td>24</td>
</tr>
<tr>
<td>21.0</td>
<td>LAMPS &amp; SOCKETS</td>
<td>25</td>
</tr>
<tr>
<td>22.0</td>
<td>Bushings, Hollow Column Insulators, Support Insulators:</td>
<td>25</td>
</tr>
<tr>
<td>23.0</td>
<td>MOTORS</td>
<td>26</td>
</tr>
<tr>
<td>24.0</td>
<td>TECHNICAL REQUIREMENT OF EQUIPMENT</td>
<td>28</td>
</tr>
<tr>
<td>Annexure A</td>
<td>LIST OF SPECIFICATIONS</td>
<td>30</td>
</tr>
<tr>
<td>Annexure B</td>
<td>LIST OF DRAWINGS/DOCUMENTS</td>
<td>39</td>
</tr>
</tbody>
</table>
1.0 FOREWORD

1.1 The provisions under this chapter are intended to supplement general requirements for the materials, equipment and services covered under other chapters of tender documents and is not exclusive.

2.0 GENERAL REQUIREMENT

2.1 The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

2.2 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Purchaser.

2.3 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification and bid price schedule but which are necessary for commissioning and satisfactory operation of the switchyard/substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of Nepal/relevant IEC standard or Acceptable International Standard.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure-A of this chapter, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IEC or equivalent international standard.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-A / individual chapters for various equipment shall also, be accepted, however the salient points of difference shall be clearly brought out in the Additional information schedule of the bid along with English language version of such standard. The equipment conforming to standards other than specified under
Annexure-A/ individual chapters for various equipment shall be subject to Purchaser's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1 The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.

4.5 The equipment shall also comply to the following:
   a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
   b) All piping, if any between equipment control cabinet/ operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 Equipment and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.6.1 System Parameter

220kV System

<table>
<thead>
<tr>
<th>SL No</th>
<th>Description of parameters</th>
<th>220 kV System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>System operating voltage</td>
<td>220kV</td>
</tr>
<tr>
<td>2.</td>
<td>Maximum operating voltage of the system (rms)</td>
<td>245kV</td>
</tr>
<tr>
<td>3.</td>
<td>Rated frequency</td>
<td>50Hz</td>
</tr>
<tr>
<td>4.</td>
<td>No. of phase</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>i) Full wave impulse withstand voltage (1.2/50 microsec.)</td>
<td>1050 kVp</td>
</tr>
<tr>
<td></td>
<td>ii) Switching impulse withstand voltage (250/2500 micro sec.) dry and wet</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>iii) One minute power frequency dry withstand voltage (rms)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>iv) One minute power frequency dry and wet withstand voltage (rms)</td>
<td>460kV</td>
</tr>
<tr>
<td>6.</td>
<td>Corona extinction voltage</td>
<td>156kV</td>
</tr>
<tr>
<td>7.</td>
<td>Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 156kV rms for 220kV system</td>
<td>1000 microvolt</td>
</tr>
<tr>
<td>8.</td>
<td>Minimum creepage distance (25mm/kV)</td>
<td>6125 mm</td>
</tr>
<tr>
<td>9.</td>
<td>i. Phase to phase</td>
<td>2100 mm</td>
</tr>
</tbody>
</table>
### 1. Description of parameters for 220 kV System

<table>
<thead>
<tr>
<th>SL No</th>
<th>Description of parameters</th>
<th>220 kV System</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii.</td>
<td>Phase to earth</td>
<td>2100 mm</td>
</tr>
<tr>
<td>iii)</td>
<td>Sectional clearances</td>
<td>5000 mm</td>
</tr>
<tr>
<td>10.</td>
<td>Rated short circuit current for 1 sec. duration</td>
<td>40kA</td>
</tr>
<tr>
<td>11.</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
</tr>
</tbody>
</table>

### 132kV & 33kV System

<table>
<thead>
<tr>
<th>SL No</th>
<th>Description of parameters</th>
<th>132 kV System</th>
<th>33 kV System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>System operating voltage</td>
<td>132kV</td>
<td>33kV</td>
</tr>
<tr>
<td>2.</td>
<td>Maximum operating voltage of the system(rms)</td>
<td>145kV</td>
<td>36kV</td>
</tr>
<tr>
<td>3.</td>
<td>Rated frequency</td>
<td>50Hz</td>
<td>50Hz</td>
</tr>
<tr>
<td>4.</td>
<td>No. of phase</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Rated Insulation levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Full wave impulse withstand voltage (1.2/50 microsec.)</td>
<td>650 kVp</td>
<td>170 kVp</td>
</tr>
<tr>
<td></td>
<td>ii) One minute power frequency dry and wet withstand voltage (rms)</td>
<td>275kV</td>
<td>70kV</td>
</tr>
<tr>
<td>6.</td>
<td>Corona extinction voltage</td>
<td>105kV</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 92KV rms for 132KV system</td>
<td>500 microvolt</td>
<td>-</td>
</tr>
<tr>
<td>8.</td>
<td>Minimum creepage distance (25mm/kV)</td>
<td>3625 mm</td>
<td>900 mm</td>
</tr>
<tr>
<td>9.</td>
<td>Min. Clearances</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Phase to phase</td>
<td>1300 mm</td>
<td>320 mm</td>
</tr>
<tr>
<td></td>
<td>ii. Phase to earth</td>
<td>1300 mm</td>
<td>320 mm</td>
</tr>
<tr>
<td></td>
<td>iii) Sectional clearances</td>
<td>4000 mm</td>
<td>3000 mm</td>
</tr>
<tr>
<td>10.</td>
<td>Rated short circuit current</td>
<td>31.5 kA for 1 Sec</td>
<td>25 kA for 3 Sec</td>
</tr>
<tr>
<td>11.</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
</tr>
</tbody>
</table>

### Note:

1. The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable.

2. The insulation and RIV levels of the equipment shall be as per values given in the respective chapter of the equipment.
4.6.2 **Major technical parameters of bushings / hollow column / support insulators are given below:**

**220kV System**

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Parameters</th>
<th>220 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Max. System voltage Um(kV)</td>
<td>245</td>
</tr>
<tr>
<td>(b)</td>
<td>Impulse withstand voltage (dry &amp; wet) (kVp)</td>
<td>± 1050</td>
</tr>
<tr>
<td>(c)</td>
<td>Power frequency withstand voltage (dry and wet) (kV rms)</td>
<td>460</td>
</tr>
<tr>
<td>(d)</td>
<td>Total creepage distance (min) (mm)</td>
<td>6125</td>
</tr>
</tbody>
</table>

**132kV & 33kV System**

| S.N. | Parameters                                      | 132 kV | 33kV |
|------|-------------------------------------------------|--------|
| (a)  | Max. System voltage Um(kV)                      | 145    | 36   |
| (b)  | Impulse withstand voltage (dry & wet) (kVp)     | ± 650  | ± 170|
| (c)  | Power frequency withstand voltage (dry and wet) (kV rms) | 275    | 75   |
| (d)  | Total creepage distance (min) (mm)              | 3625   | 900  |

4.6.3 **Major Technical Parameters**

The major technical parameters of the equipment are given below. For other parameters and features respective technical chapters should be referred.

4.6.3.1

**(A) For 245 kV & 145 kV Circuit Breaker and Isolator**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>245</th>
<th>145</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage kV (rms)</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>Rated frequency (Hz)</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>No. of Poles</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Design ambient temperature (°C)</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Rated insulation levels:

1) Full wave impulse withstand voltage (1.2/50 micro sec.)
   - between line terminals and ground ± 1050 kVp ± 650 kVp
   - between terminals with circuit breaker open ± 1050 kVp ± 650 kVp
   - between terminals with isolator open ± 1200 kVp ± 750 kVp

2) One minute power frequency dry and wet withstand voltage
- between line terminals and ground 460 kV (rms) 275 kV (rms)
- between terminals with circuit breaker open 460 kV (rms) 275 kV (rms)
- between terminals with Isolator open 530 kV (rms) 315kV (rms)

Max. radio interference voltage (microvolts) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment.

<table>
<thead>
<tr>
<th></th>
<th>1000</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>(at 156 kV rms)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(at 92 kV rms)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minimum creepage distance :-

<table>
<thead>
<tr>
<th></th>
<th>Phase to ground (mm)</th>
<th>6125</th>
<th>3625</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between CB Terminals (mm)</td>
<td>6125</td>
<td>3625</td>
<td></td>
</tr>
<tr>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
<td></td>
</tr>
<tr>
<td>Seismic acceleration</td>
<td>- 0.5g horizontal -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rating of Auxiliary Contacts</td>
<td>10 A at 220/110 V DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaking capacity of Auxiliary Contacts</td>
<td>2 A DC with circuit time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>constant of not less than 20ms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase to phase spacing (mm)</td>
<td>4500 or 4000</td>
<td>3000 or 2700</td>
<td></td>
</tr>
</tbody>
</table>

Auxiliary Switch shall also comply with other clauses of this chapter.

(B) FOR 245 kV & 145 kV CT/CVT/SA

<table>
<thead>
<tr>
<th></th>
<th>245</th>
<th>145</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage kV (rms)</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>Rated frequency (Hz)</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>No. of poles</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Design ambient temperature (°C)</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Rated insulation levels:

1) Full wave impulse withstand voltage (1.2/50 micro sec.)

<table>
<thead>
<tr>
<th></th>
<th>± 1050 kVp</th>
<th>±650 kVp</th>
</tr>
</thead>
<tbody>
<tr>
<td>(between line terminals and ground for CT and CVT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(for arrester housing)</td>
<td>± 1050 kV peak</td>
<td>±650 kVp</td>
</tr>
</tbody>
</table>

2) One minute power frequency dry and wet withstand voltage

<table>
<thead>
<tr>
<th></th>
<th>460 kV rms</th>
<th>275 kV rms</th>
</tr>
</thead>
<tbody>
<tr>
<td>(between line terminals and ground for CT and CVT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(for arrester housing)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Max. radio interference voltage (microvolts) for frequency between 0.5 MHz

<table>
<thead>
<tr>
<th></th>
<th>1000 for CT/CVT</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>(at 156 kV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(at 92 kV)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
and 2 MHz in all positions of the equipment.

Minimum creepage distance :-

<table>
<thead>
<tr>
<th>Phase to ground (mm)</th>
<th>6125</th>
<th>3625</th>
</tr>
</thead>
</table>

System neutral earthing - Effectively earthed -

Seismic acceleration - 0.5g horizontal -

Partial discharge for :-

- Surge arrester at 1.05 COV - Not exceeding 50 pc. -
- for CT/CVT - Not exceeding 10 pc. –

(C) For 33 kV Vacuum Circuit Breaker and Isolator:

<table>
<thead>
<tr>
<th>Rated voltage kV (rms)</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated frequency (Hz)</td>
<td>50</td>
</tr>
<tr>
<td>No. of Poles</td>
<td>3</td>
</tr>
<tr>
<td>Design ambient temperature (°C)</td>
<td>50</td>
</tr>
</tbody>
</table>

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)
   - between line terminals and ground ±170 kVp
   - between terminals with circuit breaker open ±170 kVp
   - between terminals with isolator open ±170 kVp

2) One minute power frequency dry and wet withstand voltage
   - between line terminals and ground 70kV(rms)
   - between terminals with circuit breaker open 70kV(rms)
   - between terminals with Isolator open 70kV(rms)

Minimum creepage distance:

<table>
<thead>
<tr>
<th>Phase to ground (mm)</th>
<th>900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between CB Terminals (mm)</td>
<td>900</td>
</tr>
</tbody>
</table>

System neutral earthing Effectively earthed
Seismic acceleration 0.5 g
Rating of Auxiliary Contacts 10 A at 250 V DC

Breaking capacity of Auxiliary Contacts 2 A DC with circuit time constant of not less than 20ms
Auxiliary Switch shall also Comply with other clauses of Chapter-GTR.

**(D)** FOR 33kV CT/VT/SA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage (kV) (rms)</td>
<td>36</td>
</tr>
<tr>
<td>Rated frequency (Hz)</td>
<td>50</td>
</tr>
<tr>
<td>No. of poles</td>
<td>1</td>
</tr>
<tr>
<td>Design ambient temperature (°C)</td>
<td>50</td>
</tr>
</tbody>
</table>

**Rated insulation levels:**

1. Full wave impulse withstand voltage (1.2/50 micro sec.)
   - between line terminals and ground ±170 kVp
   - for arrester housing ±170 kVp
2. One minute power frequency dry and wet withstand voltage
   - between line terminals and ground 70kV rms
   - for arrester housing 70kV rms

**Minimum creepage distance:**

- Phase to ground (mm) 900
- Between Terminals (mm) 900
- System neutral earthing - Effectively earthed -
- Seismic acceleration 0.5 g
- Cantilever strength of bushing 350 kg (minimum)

**(E)** Technical Parameters of Bushings/Hollow Column Insulators/support insulators for 33kV:

1. **Rated Voltage (kV):** 36
2. **Impulse withstand voltage (Dry & Wet) (kVp):** ±170
3. **Power frequency withstand voltage (dry and wet) (kV rms):** 75
4. **Total creepage distance (mm):** 900
5. **Pollution Class-III Heavy (as per IEC 71) and as specified in Section-2 for all class of equipment.**

The requirement of alternate long & short sheds stated in model technical specification shall not be applicable in case of 33 kV.
5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award.

The Contractor shall necessarily submit all the drawings/documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/design documents/data/detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. Employer/Consultant has standardized few drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings along with type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.4 The review of these data by the Purchaser will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Purchaser shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

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

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Purchaser in Writing.
5.7 **Approval Procedure**

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i) **Approval/comments/****  
   by Purchaser on initial submission  
   
   As per agreed schedule

ii) **Resubmission**  
   (whenever required)  
   
   Within 3 (three) weeks from date of comments

iii) **Approval or comments**  
   
   Within 3 (three) weeks of receipt of resubmission.

iv) **Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre)**  
   
   2 weeks from the date of approval

v) **Furnishing of distribution copies of test reports**  
   (a) **Type test reports**  
   (one scanned softcopy in pdf format per substation  
   plus one for corporate centre & one hardcopy per substation)  
   
   2 weeks from the date of final approval

   (b) **Routine Test Reports**  
   (one copy for each substation)  
   
   -do-

vi) **Furnishing of instruction/operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)**  
   
   As per agreed schedule

(vii) **As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre& per substation)**  
   
   On completion of entire works

**NOTE:**

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with
complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Purchaser.

(5) The Contractor shall furnish to the Purchaser catalogues of spare parts.

(6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 Incase where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the
manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.2 Provisions for Exposure to Hot and Humid climate

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

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 230V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

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

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55
b) Installed indoor in air conditioned area: IP-31

c) Installed in covered area: IP-52

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

e) For LT Switchgear (AC & DC distribution Boards): IP-52

The degree of protection shall be in accordance with IEC-60947 (Part-I) / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

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

6.3.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipment shall be provided with English inscriptions.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

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

7.3 The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor’s and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his
own cost at Owner’s Corporate Centre, Nepal or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor’s Works or at his Sub-contractor’s premises or at the Purchaser’s site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the contractor shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme;

(b) Documentation control system;

(c) Qualification data for bidder’s key personnel;

(d) The procedure for purchases of materials, parts components and selection of sub-Contractor’s services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;

(f) Control of non-conforming items and system for corrective actions;

(g) Inspection and test procedure both for manufacture and field activities.

(h) Control of calibration and testing of measuring instruments and field activities;

(i) System for indication and appraisal of inspection status;

(j) System for quality audits;

(k) System for authorising release of manufactured product to the Purchaser.

(l) System for maintenance of records;

(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

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

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of purchaser’s inspection of equipment/material.
9.0 **TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE**

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective chapters.

9.2 The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the originally scheduled date of bid opening. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally scheduled date of bid opening.

i) Lightning Impulse Test

ii) Switching Impulse Test

iii) Multiple Chopped Impulse Test (For CT)

iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The Contractor shall intimate the Purchaser the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the contractor.

9.3 The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of
9.4 The Contractor shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and Purchaser. Such tests shall be to the Contractor’s account except for the expenses of the Inspector. The Purchaser /inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector’s presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.5 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.6 When the factory tests have been completed at the Contractor’s or Sub-Contractor’s works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor’s Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.7 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser /Inspector or to his authorised representative to accomplish testing.

9.8 The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.9 The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor’s premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.10 The Purchaser reserves the right for getting any field tests not specified in respective chapters of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Purchaser.
10.0 TESTS

10.1 Pre-commissioning Tests

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

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to Equivalent International Standards.
12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, uneveness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

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

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IEC.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanized material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005/Equivalent International standard “Code of practice for phosphating iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.
12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective chapters of the equipment. Glossy white colour inside the equipment /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PIPE LINE</th>
<th>Base colour</th>
<th>Band colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hydrant and Emulsifier system pipeline</td>
<td>FIRE RED</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Emulsifier system detection line – water</td>
<td>FIRE RED</td>
<td>Sea Green</td>
</tr>
<tr>
<td>3</td>
<td>Emulsifier system detection line – Air</td>
<td>FIRE RED</td>
<td>Sky Blue</td>
</tr>
<tr>
<td>4</td>
<td>Pylon support pipes</td>
<td>FIRE RED</td>
<td></td>
</tr>
</tbody>
</table>

**Fire Protection System**

**Air Conditioning System**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PIPE LINE</th>
<th>Base colour</th>
<th>Band colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Refrigerant gas pipeline – at compressor suction</td>
<td>Canary Yellow</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Refrigerant gas pipeline – at compressor discharge</td>
<td>Canary Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>7</td>
<td>Refrigerant liquid pipeline</td>
<td>Dark Admiralty Green</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Chilled water pipeline</td>
<td>Sea Green</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Condenser water pipeline</td>
<td>Sea Green</td>
<td>Dark Blue</td>
</tr>
</tbody>
</table>

The direction of flow shall be marked by → (arrow) in black colour.

Base Colour Direction of flow Band Colour

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.
13.0 HANDLING, STORING AND INSTALLATION

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

13.2 Contractor may engage manufacturer’s Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer’s supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipment shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipment are to be stored indoors only.

Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer’s recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer’s drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer’s drawings/instructions correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6 Contractor shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser’s information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at
Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10 The words 'erection' and 'installation' used in the specification are synonymous.

13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.13 Equipment Bases

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

14.0 TOOLS AND TACKLES

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

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under chapter “Electrical & Mechanical Auxiliaries” having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

<table>
<thead>
<tr>
<th>Normal Voltage</th>
<th>Variation in Voltage</th>
<th>Frequency in HZ</th>
<th>Phase/Wire</th>
<th>Neutral connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>400V</td>
<td>± 10</td>
<td>50 ± 2.5%</td>
<td>3/4 Wire</td>
<td>Solidly Earthed.</td>
</tr>
<tr>
<td>230V</td>
<td>± 10</td>
<td>50 ± 2.5%</td>
<td>1/2 Wire</td>
<td>Solidly Earthed.</td>
</tr>
<tr>
<td>220V</td>
<td>190V to 240V</td>
<td>DC</td>
<td>-</td>
<td>Isolated 2 wire</td>
</tr>
<tr>
<td>Voltage</td>
<td>Range</td>
<td>System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110V</td>
<td>95V to 120V</td>
<td>DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isolated 2 wire System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48V</td>
<td></td>
<td>DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 wire system (+) earthed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Combined variation of voltage and frequency shall be limited to ± 10%.

16.0 SUPPORT STRUCTURE

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 5.9 meter from plinth level for 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to ANSI/NEMA CC1/ Equivalent International standard and shall be made of materials listed below:

For connecting ACSR conductors, Aluminum alloy casting conforming to BS:1490/ Equivalent International Standard

For connecting equipment terminals made of copper with ACSR conductors, Bimetallic connectors made from aluminum alloy casting conforming to BS:1490/ Equivalent International Standard with 2mm thick bimetallic liner.

For connecting GI, Galvanized mild shield wire

i) Bolts, nuts and plain washers Electrogalvanised for sizes Plain, washers below M12, for others hot dip galvanised.

ii) Spring washers for item ‘a’ to ‘c’ Electrogalvanised mild steel

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.
17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per NEMA CC1/ Equivalent International Standard and shall also be subjected to routine tests as per NEMA CC1/ Equivalent International Standard. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)

ii) Short time current test

iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)

iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.
18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, BS:4255/ Equivalent International Standard. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

18.7 A 230V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch.

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

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

18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 a) The following routine tests alongwith the routine tests as per IEC 60529/ Equivalent International Standard shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IEC 60529/ Equivalent International Standard
including application of, 2.0 kV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19.0 Void.

20.0 TERMINAL BLOCKS AND WIRING

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

20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago or equivalent make.

20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

20.6 The terminal blocks shall be of extensible design.

20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a) All circuits except CT/PT circuits Minimum of two of 2.5 sq mm copper flexible.

b) All CT/PT circuits Minimum of 4 nos. of 2.5 sq mm copper flexible.

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted
marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

21.0 LAMPS & SOCKETS

21.1 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round plug as per Nepalese Standard. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 230 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

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

21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228/ Equivalent International Standard mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155. The support insulators shall be manufactured and tested as per IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS: 2544 & IS : 5621/ Equivalent International Standard.

23.0 MOTORS

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

23.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IEC 60529/ Equivalent International Standard. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691/ Equivalent International Standard.

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Chapter.
23.3 **Starting Requirements:**

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325/ Equivalent International Standard.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 **Running Requirements:**

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325/ Equivalent International Standard (for 3-phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729/ Equivalent International Standard. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 **TESTING AND COMMISSIONING**

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.
24.0 TECHNICAL REQUIREMENT OF EQUIPMENT

24.1 1.1 KV Grade Power & Control Cables

24.1.1 Applicable for PVC Control Cable

The manufacturers, whose PVC control cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1 KV grade PVC insulated control cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the originally Scheduled date of bid opening.

24.1.2 Applicable for PVC Power Cable

The manufacturer, whose PVC Power Cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1 KV or higher grade PVC insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.1.3 Applicable for XLPE Power Cables

The Manufacturer, whose XLPE Power cables are offered, should have designed, manufactured, tested and supplied in a single contract atleast 25 Kms of 1.1 KV or higher grade XLPE insulated power cables as on the date of bid opening. Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the originally Scheduled date of bid opening.

24.2 LT Switchgear

24.2.1 The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos MCC panels comprising of MCCBs (ie Moulded Case Circuit Breakers) modules of the type offered which should be in successful operation as on originally Scheduled date of bid opening.

24.2.2 The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design. At least one hundred circuit breakers of the make and type being offered shall be operating satisfactory as on originally Scheduled date of bid opening.

24.3 Fire Fighting System

The bidder or his sub-vendor should have designed, supplied, tested, erected and commissioned at least one number fire protection system of the each type described in (i), (ii) and (iii) below in installations such as power plants, substations, refineries, fertilizer plants or other industrial or commercial installations. Such systems must have been designed and comply to International Standard code (FOC, LONDON or NFPA, USA etc) executed during last ten (10) years and should have been in successful operation for at least 2 years as on the originally Scheduled date of bid opening.

(i) Automatic hydrant type fire protection system.
(ii) Automatic high velocity or automatic medium velocity water spray type fire protection system

(iii) Smoke detection system.

In case bidder himself do not meet the requirement of design, he can engage a consultant(s) who must have designed i) Automatic hydrant type fire protection system, ii) Automatic high velocity or automatic medium velocity water spray type fire protection system and iii) Smoke detection system, which must be in successful operation for at least two years as on the originally Scheduled date of bid opening.
Annexure A: LIST OF SPECIFICATIONS

GENERAL STANDARDS AND CODES

IEC-60060 (Part 1 to P4) - High Voltage Test Techniques
IEC 60068 - Environmental Test
IEC-60117 - Graphical Symbols
IEC-60270, - Partial Discharge Measurements.
IEC-60376 - Specification and Acceptance of New Sulphur Hexafluoride
IEC-60437 - Radio Interference Test on High Voltage Insulators.
IEC-60507 - Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.
IEC-62271-1 - Common Specification for High Voltage Switchgear & Controlgear Standards.
IEC-60865 (P1 & P2) - Short Circuit Current - Calculation of effects.
ANSI-C.1/NFPA.70 - National Electrical Code
ANSI-C63.21, - Specification for Electromagnetic Noise and C63.3 - Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4/ANSI-C68.1 - Technique for Dielectric Tests
ANSI-C76.1/EEE21 - Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4 - Specification for Sound Level Metres
ANSI-Y32-2/C337.2 - Drawing Symbols
ANSI-Z55.11 - Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T - Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II - General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1 - Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h - Quality Assurance Program Requirements
CSA-Z299.2-1979h - Quality Control Program Requirements
CSA-Z299.3-1979h - Quality Verification Program Requirements
CSA-Z299.4-1979h - Inspection Program Requirements
## Transformers and Reactors

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC-60076 (Part 1 to 5)</td>
<td>Power Transformers</td>
</tr>
<tr>
<td>IEC-60214</td>
<td>On-Load Tap-Changers.</td>
</tr>
<tr>
<td>IEC-60289</td>
<td>Reactors.</td>
</tr>
<tr>
<td>IEC-60354</td>
<td>Loading Guide for Oil - Immersed power transformers</td>
</tr>
<tr>
<td>IEC-60076-10</td>
<td>Determination of Transformer and Reactor Sound Levels</td>
</tr>
<tr>
<td>ANSI-C571280</td>
<td>General requirements for Distribution, Power and Regulating Transformers</td>
</tr>
<tr>
<td>ANSI-C571290</td>
<td>Test Code for Distribution, Power and Regulation Transformers</td>
</tr>
<tr>
<td>ANSI-C5716</td>
<td>Terminology &amp; Test Code for Current Limiting Reactors</td>
</tr>
<tr>
<td>ANSI-C5721</td>
<td>Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA</td>
</tr>
<tr>
<td>ANSI-C5792</td>
<td>Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise</td>
</tr>
<tr>
<td>ANSI-CG,1EEE-4</td>
<td>Standard Techniques for High Voltage Testing</td>
</tr>
</tbody>
</table>

## Circuit Breakers

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC-62271-100</td>
<td>High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers</td>
</tr>
<tr>
<td>IEC-62271-101</td>
<td>High-voltage switchgear and controlgear - Part 101: Synthetic testing</td>
</tr>
<tr>
<td>IEC-62155</td>
<td>Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V</td>
</tr>
<tr>
<td>IEC-62271-110</td>
<td>High-voltage switchgear and controlgear - Part 110: Inductive load switching</td>
</tr>
<tr>
<td>IEC-62271-109</td>
<td>High-voltage switchgear and controlgear - Part 110: Inductive load switching</td>
</tr>
</tbody>
</table>

## Current Transformers, Voltage Transformers and Coupling Capacitor Voltage Transformers

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC-60044-1</td>
<td>Current transformers.</td>
</tr>
<tr>
<td>IEC-60044-2</td>
<td>Inductive Voltage Transformers.</td>
</tr>
<tr>
<td>IEC-60044-5</td>
<td>Instrument transformers - Part 5: Capacitor voltage transformers</td>
</tr>
<tr>
<td>IEC-60358</td>
<td>Coupling capacitors and capacitor dividers.</td>
</tr>
</tbody>
</table>
IEC-60044-4 - Instrument Transformes : Measurement of Partial Discharges
IEC-60481 - Coupling Devices for power Line Carrier Systems.
ANSI-C5713 - Requirements for Instrument transformers
ANSIC92.2 - Power Line Coupling voltage Transformers
ANSI-C93.1 - Requirements for Power Line Carrier Coupling Capacitors

BUSHING
IEC-60137 - Insulated Bushings for Alternating Voltages above 1000V

SURGE ARRESTERS
IEC-60099-4 - Metal oxide surge arrestors without gaps
IEC-60099-5 - Selection and application recommendation
ANSI-C62.1 - IEE Standards for S A for AC Power Circuits
NEMA-LA 1 - Surge Arresters

CUBICLES AND PANELS & OTHER RELATED EQUIPMENT
IEC-60068.2.2 - Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60529 - Degree of Protection provided by enclosures.
IEC-60947-4-1 - Low voltage switchgear and control gear.
IEC-61095 - Electromechanical Contactors for household and similar purposes.
IEC-60439 (P1 & 2) - Low Voltage Switchgear and control gear assemblies
ANSI-C37.20 - Switchgear Assemblies, including metal enclosed bus.
ANSI-C37.50 - Test Procedures for Low Voltage Alternating Current Power Circuit Breakers
ANSI-C39 - Electric Measuring instrument
ANSI-C83 - Components for Electric Equipment
NEMA-AB - Moulded Case Circuit and Systems
NEMA-CS - Industrial Controls and Systems
NEMA-PB-1 - Panel Boards
NEMA-SG-5 - Low voltage Power Circuit breakers
NEMA-SG-3 - Power Switchgear Assemblies
NEMA-SG-6 - Power switching Equipment
NEMA-5E-3 - Motor Control Centers
1248 (P1 to P9) - Direct acting indicating analogue electrical measuring instruments & their accessories.

Disconnecting switches
IEC-62271-102 - High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC-60265 (Part 1 & 2) - High Voltage switches
ANSI-C37.32 - Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34 - Test Code for high voltage air switches
NEMA-SG6 - Power switching equipment

**PLCC and line traps**

IEC-60353 - Line traps for A.C. power systems.
IEC-60481 - Coupling Devices for power line carrier systems.
IEC-60495 - Single sideboard power line carrier terminals
IEC-60683 - Planning of (single Side-Band) power line carrier systems.
CIGRE - Teleprotection report by Committee 34 & 35.
CCIR - International Radio Consultative Committee
CCITT - International Telegraph & Telephone Consultative Committee
EIA - Electric Industries Association

**Protection and control equipment**

IEC-60051: (P1 to P9) - Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to 23) - Electrical relays.
IEC-60297 (P1 to P4) - Dimensions of mechanical structures of the 482.6mm (19 inches) series.
IEC-60387 - Symbols for Alternating-Current Electricity meters.
IEC-60447 - Man machine interface (MMI) - Actuating principles.
IEC-60521 - Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547 - Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81 - Screw threads
ANSI-B18 - Bolts and Nuts
ANSI-C37.1 - Relays, Station Controls etc.
ANSI-C37.2 - Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2 - Relays and relay systems associated with electric power apparatus
**ANSI-C39.1** - Requirements for electrical analog indicating instruments

**MOTORS**

IEC-60034 (P1 to P19:) - Rotating electrical machines

IEC-Document 2 - Three phase induction motors

(Central Office) NEMA-MGI Motors and Generators

**Electronic equipment and components**

MIL-21B, MIL-833 & MIL-2750

IEC-60068 (P1 to P5) - Environmental testing

IEC-60326 (P1 to P2) - Printed boards

Material and workmanship standards

ASTM - Specification and tests for materials

**Clamps & connectors**

NEMA-CC1 - Electric Power connectors for sub station

NEMA-CC 3 - Connectors for Use between aluminium or aluminum-Copper Overhead Conductors

**Bus hardware and insulators**

IEC-60120 - Dimensions of Ball and Socket Couplings of string insulator units.

IEC-60137 - Insulated bushings for alternating voltages above 1000 V.

IEC-60168 - Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V.

IEC-62155 - Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V.

IEC-60273 - Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.

IEC-61462 - Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations

IEC-60305 - Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pintype.


IEC-60383 (P1 and P2) - Insulators for overhead lines with a nominal voltage above 1000 V.

IEC-60433 - Characteristics of string insulator units of the long rod type.
IEC-60471 - Dimensions of Clevis and tongue couplings of string insulator units.

ANSI-C29 - Wet process procelain insulators

ANSI-C29.1 - Test methods for electrical power insulators

ANSI-C92.2 - For insulators, wet-process porcelain and toughened glass suspension type

ANSI-C29.8 - For wet-process porcelain insulators apparatus, post-type

ANSI-G.8 - Iron and steel hardware

CISPR-7B - Recommendations of the CISPR, tolerances of form and of Position, Part 1

ASTM A-153 - Zinc Coating (Hot-Dip) on iron and steel hardware

**Strain and rigid bus-conductor**

ASTM-B 230-82 - Aluminum 1350 H19 Wire for electrical purposes

ASTM-B 231-81 - Concentric - lay - stranded, aluminum 1350 conductors

ASTM-B 221 - Aluminum - Alloy extruded bar, road, wire, shape

ASTM-B 236-83 - Aluminum bars for electrical purpose (Bus-bars)

ASTM-B 317-83 - Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)

**Batteries and batteries charger**

**Battery**

IEC:60896-21&22 - Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements

IEC: 60623 - Vented type nickel Cadmium Batteries

IEC:60622 - Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell

IEC:60623 - Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell

IEC:60896-11 - Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests

IEEE-485 - Recommended practices for sizing of Lead Acid Batteries

IEEE-1115 - Sizing of Ni-Cd Batteries

IEEE-1187 - Recommended practices for design & installation of VRLA Batteries

IEEE-1188 - Recommended practices for design & installation of VRLA Batteries

IEEE-1189 - Guide for selection of VRLA Batteries

**Battery Charger**

IEEE-484 - Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations.
IEEE-485 - Sizing large lead storage batteries for generating stations and substations

Wires and cables
ASTMD-2863 - Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IEC-60096 (part 0 to p4) - Radio Frequency cables.
IEC-60183 - Guide to the Selection of High Voltage Cables.
IEC-60189 (P1 to P7) - Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60227 (P1 to P7) - Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60228 - Conductors of insulated cables
IEC-60230 - Impulse tests on cables and their accessories.
IEC-60287 (P1 to P3) - Calculation of the continuous current rating of cables (100% load factor).
IEC-60304 - Standard colours for insulation for low-frequency cables and wires.
IEC-60331 - Fire resisting characteristics of Electric cables.
IEC-60332 (P1 to P3) - Tests on electric cables under fire conditions.
IEC-60502 - Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2) - Tests on gases evolved during combustion of electric cables.

Painting
ANSI-Z551 - Gray finishes for industrial apparatus and equipment
SSPEC - Steel structure painting council

HORIZONTAL CENTRIFUGAL PUMPS
API-610 - Centrifugal pumps for general services
- Hydraulic Institutes Standards
BS:599 - Methods of testing pumps
PTC-8.2 - Power Test Codes - Centrifugal pumps

DIESEL ENGINES
ASME Power Test Code - Internal combustion engine PTC-17
- Codes of Diesel Engine Manufacturer's Association, USA

PIPEING VALVES & SPECIALITIES
BS:5150 - Specification for cast iron gate valves

PG Test Procedures
NFPA-13 - Standard for the installation of sprinkler system
NFPA-15  -  Standard for water spray fixed system for the fire protection
NFPA-12A  -  Standard for Halong 1301 Fire Extinguishing System
NFPA-72E  -  Standard on Automatic Fire Detectors
NFPA-12   -  Standard on Carbon dioxide extinguisher systems

Electrical generating and distributing stations code of practice

Steel structures
- ANSI-B18.2.1  -  Inch series square and Hexagonal bolts and screws
- ANSI-B18.2.2  -  Square and hexagonal nuts
- ANSI-G8.14   -  Round head bolts
- ASTM-A6      -  Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
- ASTM-A36     -  Specifications of structural steel
- ASTM-A47     -  Specification for malleable iron castings
- ASTM-A143    -  Practice for safeguarding against embrittlement of Hot Galvanized structural steel products and procedure for detaching embrittlement
- ASTM-A242    -  Specification for high strength low alloy structural steel
- ASTM-A283    -  Specification for low and intermediate tensile strength carbon steel plates of structural quality
- ASTM-A394    -  Specification for Galvanized steel transmission tower bolts and nuts
- ASTM-441     -  Specification for High strength low alloy structural manganese vanadium steel.
- ASTM-A572    -  Specification for High strength low alloy columbium-Vanadium steel of structural quality
- AWS D1-0     -  Code for welding in building construction welding inspection
- AWS D1-1     -  Structural welding code
- AISC        -  American institute of steel construction
- NEMA-CG1     -  Manufactured graphite electrodes

Piping and pressure vessels
- ASME        -  Boiler and pressure vessel code
- ASTM-A120   -  Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
- ASTM-A53    -  Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
- ASTM-A106   -  Seamless carbon steel pipe for high temperature service
- ASTM-A284   -  Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction.
ASTM-A234 - Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181 - Specification for forgings, carbon steel for general purpose piping
ASTM-A105 - Forgings, carbon steel for piping components
ASTM-A307 - Carbon steel externally threaded standard fasteners
ASTM-A193 - Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345 - Flat rolled electrical steel for magnetic applications
ASTM-A197 - Cupola malleable iron
ANSI-B2.1 - Pipe threads (Except dry seal)
ANSI-B16.1 - Cast iron pipe flanges and flanged fittings. Class 25, 125, 250 and 800
ANSI-B16.1 - Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5 - Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9 - Factory-made wrought steel butt welding fittings
ANSI-B16.11 - Forged steel fittings, socket-welding and threaded
ANSI-B16.14 - Ferrous pipe plug, bushings and locknuts with pipe threads
ANSI-B16.25 - Butt welding ends
ANSI-B18.1.1 - Fire hose couplings screw thread.
ANSI-B18.2.1 - Inch series square and hexagonal bolts and screws
ANSI-B18.2.2 - Square and hexagonal nuts
NSI-B18.21.1 - Lock washers
ANSI-B18.21.2 - Plain washers
ANSI-B31.1 - Power piping
ANSI-B36.10 - Welded and seamless wrought steel pipe
ANSI-B36.9 - Stainless steel pipe

ACSR MOOSE CONDUCTOR

CISPR
Part - V - Overhead Transmission Purposes
BS:215(Part-II) - Aluminium Conductors galvanized IEC:209-1966 steel reinforced extra high voltage (400 kV and above)
BS:215(Part-II)

GALVANISED STEEL EARTHWIRE

P5:1992) - overhead transmission purposes.
Annexure B: **LIST OF DRAWINGS/DOCUMENTS**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>LIST OF DRAWINGS/DOCUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single Line Diagram</td>
</tr>
<tr>
<td>2</td>
<td>Electrical Layout – Plan and Sections</td>
</tr>
<tr>
<td>3</td>
<td>Tower, Equipment &amp; cable trench layout drawing</td>
</tr>
<tr>
<td>4</td>
<td>Earthing system design calculation &amp; layout drawing</td>
</tr>
<tr>
<td>5</td>
<td>Lighting protection system design &amp; drawings</td>
</tr>
<tr>
<td>6</td>
<td>Structure Layout (Plan &amp; Section) drawing</td>
</tr>
<tr>
<td>7</td>
<td>Cantilever Strength calculations (if applicable)</td>
</tr>
<tr>
<td>8</td>
<td>Design calculation for Sag – Tension stringing chart</td>
</tr>
<tr>
<td>9</td>
<td>GTP and drawings for Bus-Post Insulator</td>
</tr>
<tr>
<td>10</td>
<td>Tension/suspension string insulator and Hardware Assembly GTP and drawing</td>
</tr>
<tr>
<td>11</td>
<td>Soil Investigation Report (if applicable)</td>
</tr>
<tr>
<td>12</td>
<td><strong>Circuit Breakers (220kV,132kV, 33 kV- As applicable)</strong></td>
</tr>
<tr>
<td></td>
<td>- GA drawing, GTP, Type test Reports</td>
</tr>
<tr>
<td>13</td>
<td><strong>CTs &amp; CVTs (220kV,132 kV, 33kV- As applicable)</strong></td>
</tr>
<tr>
<td></td>
<td>- GA drawing, GTP, Type test Reports</td>
</tr>
<tr>
<td>14</td>
<td><strong>Surge Arrestors (216kV,120kV, 30kV- As applicable)</strong></td>
</tr>
<tr>
<td></td>
<td>- GA drawing, GTP, Type test Reports</td>
</tr>
<tr>
<td>15</td>
<td><strong>Isolators (220kV,132kV, 33 kV- As applicable)</strong></td>
</tr>
<tr>
<td></td>
<td>- GA drawing, GTP, Type test Reports</td>
</tr>
<tr>
<td>16</td>
<td><strong>Control, Relay Panels and Substation Automation system</strong></td>
</tr>
<tr>
<td></td>
<td>- GTP, technical literature, type test reports</td>
</tr>
<tr>
<td>17</td>
<td><strong>PLCC, LINE TRAP &amp; Digital Protection Coupler</strong></td>
</tr>
<tr>
<td></td>
<td>- GTP and technical literature</td>
</tr>
<tr>
<td>18</td>
<td><strong>Civil Works (as applicable)</strong></td>
</tr>
<tr>
<td></td>
<td>a) Control Room Building</td>
</tr>
<tr>
<td></td>
<td>Structure Design, Foundation Design &amp; Drg., Plinth Beam Design &amp; Drg. and column Design &amp; Drg. up to G.F. Level</td>
</tr>
<tr>
<td></td>
<td>b) Auto transformer foundation design/drawings</td>
</tr>
<tr>
<td></td>
<td>c) Reactor foundation design/drawings</td>
</tr>
<tr>
<td></td>
<td>d) 220/132/33kV Tower, structure &amp; foundation design/drawings.</td>
</tr>
<tr>
<td></td>
<td>e) 220/132/33kV Equipment support structure &amp; foundation design/drawing</td>
</tr>
</tbody>
</table>

**NOTE:**

1. The above list of drawing/document is only illustrative and not exhaustive. The contractor shall submit drawings/documents as per requirement of Technical specification.
### CHAPTER 3– SWITCHGEAR

#### CIRCUIT BREAKERS

<table>
<thead>
<tr>
<th>Clause. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>General</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty Requirements:</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>Total Break Time:</td>
<td>2</td>
</tr>
<tr>
<td>4.0</td>
<td>Constructional Features:</td>
<td>2</td>
</tr>
<tr>
<td>5.0</td>
<td>Sulphur Hexafluoride Gas (Sf6 Gas):</td>
<td>3</td>
</tr>
<tr>
<td>6.0</td>
<td>Insulators:</td>
<td>4</td>
</tr>
<tr>
<td>7.0</td>
<td>Spare Parts And Mandatory Maintenance Equipment:</td>
<td>4</td>
</tr>
<tr>
<td>8.0</td>
<td>Operating Mechanism And Control</td>
<td>4</td>
</tr>
<tr>
<td>9.0</td>
<td>Support Structure:</td>
<td>6</td>
</tr>
<tr>
<td>10.0</td>
<td>Terminal Connector Pad:</td>
<td>6</td>
</tr>
<tr>
<td>11.0</td>
<td>Interpole Cabling:</td>
<td>6</td>
</tr>
<tr>
<td>12.0</td>
<td>Fittings And Accessories</td>
<td>7</td>
</tr>
<tr>
<td>13.0</td>
<td>Additional Data To Be Furnished:</td>
<td>7</td>
</tr>
<tr>
<td>14.0</td>
<td>Tests:</td>
<td>8</td>
</tr>
<tr>
<td>15.0</td>
<td>Technical Parameters:</td>
<td>9</td>
</tr>
<tr>
<td>16.0</td>
<td>Pre-Commissioning Tests</td>
<td>13</td>
</tr>
</tbody>
</table>
CHAPTER - SWITCHGEAR
CIRCUIT BREAKERS

1.0 GENERAL

1.1 The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-01 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in Chapter 2-GTR.

1.2 245/145 kV live tank type circuit breakers offered would be of sulphur hexafluoride (SF6) type only and of class C2-M2 as per IEC

1.3 The circuit breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, interpole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanised support structure for CB and control cabinets, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform.

All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts, connectors and other devices whether specifically called for herein or not shall be provided.

1.4 Painting shall be done in line with Chapter 2 –GTR. REL-5032 or similar shades can be used for painting. The support structure of circuit breaker shall be hot dip galvanised. Exposed hardware items shall be hot dip galvanised or Electro-galvanised.

1.5 The circuit breakers shall be designed for use in the geographic and meteorological conditions as given in Chapter 2–GTR.

2.0 DUTY REQUIREMENTS:

2.1 The circuit breakers shall be capable of performing their duties without opening resistors.

2.2 The circuit breaker shall meet the duty requirements for any type of fault or fault location also for line switching when used on a 245/145 kV effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.3 The breaker shall be capable of interrupting the steady state and transient magnetising current corresponding of power transformers.

2.4 The circuit breaker shall also be capable of:

i) Interrupting line/cable charging current as per IEC without use of opening resistors.

ii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
iii) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

2.5 The Breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges. The breaker shall also withstand the voltages specified under Clause 15 of this Chapter.

3.0 TOTAL BREAK TIME:

3.1 The total break time as specified under this Chapter shall not be exceeded under any of the following duties:

i) Test duties T10, T30, T60, T100a, T100s (TRV as per IEC: 62271-100)

ii) Short line fault L75, L90

3.2 The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%) and arc extinguishing medium pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidders may specifically bring out the effect of non-simultaneity between contacts between poles and show how it is covered in the guaranteed total break time.

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

4.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of circuit breakers shall be in accordance with requirements stated hereunder:

4.1 Contacts

4.1.1 The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for 8 hours at zero gauge pressure of SF6 gas due to the leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. 2 p.u. across the breaker continuously, for validation of which a power frequency dielectric with stand test conducted for a duration of at least 15 minutes is acceptable).

4.2 The SF6 Circuit Breaker shall meet the following additional requirements:

a) The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.

b) All gasketted surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas
leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning of circuit breaker, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during first year of operation after commissioning.

c) In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF6 gas decomposition products.

d) Each pole shall form an enclosure filled with SF6 gas independent of two other poles (for 245 kV CBs) and the SF6 density of each pole shall be monitored. For CBs of voltage class of 145 kV or less, a common SF6 scheme/density monitor shall be acceptable.

e) The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker as a whole. The density monitor shall have graduated scale and shall meet the following requirements:

i) It shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non return valve coupling.

f) Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.

g) Sufficient SF6 gas including that will be required for gas analysis during filling shall be provided to fill all the circuit breakers installed. In addition spare gas shall be supplied in separate unused cylinders as per requirement specified in Chapter 1---PSR.

4.3 Provisions shall be made for attaching an operational analyser to record contact travel, speed and making measurement of operating timings, preinsertion timings of closing resisters if used, synchronisation of contacts in one pole.

5.0 SULPHUR HEXAFLUORIDE GAS (SF6 GAS):

a) The SF6 gas shall comply with IEC 60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under the operating conditions.

b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations.

c) Test: SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water content as per IEC 60376, 60376A and 60376B and test certificates shall be furnished to Employer indicating all the tests as per IEC 60376 for each lot of SF6 gas in stipulated copies.
as indicated in Chapter-GTR. Gas bottles should be tested for leakage during receipt at site.

6.0 **INSULATORS:**

a) The porcelain of the insulators shall conform to the requirements stipulated under Chapter 2-GTR.

b) The mechanical characteristics of insulators shall match with the requirements specified under this Chapter.

c) All hollow insulators shall conform to IEC-62155.

d) Hollow Porcelain for pressurised columns/chambers should be in one integral piece in green and fired stage.

7.0 **SPARE PARTS AND MANDATORY MAINTENANCE EQUIPMENT:**

The bidder shall include in his proposal spare parts and maintenance equipment in accordance with Chapter 1-PSR. Calibration certificates of each maintenance equipment shall be supplied alongwith the equipment.

8.0 **OPERATING MECHANISM AND CONTROL**

8.1 **General Requirements**

8.1.1 Circuit breaker shall be operated by spring charged mechanism or hydraulic mechanism or a combination of these. The mechanism shall be housed in a weather proof and dust proof control cabinet as stipulated in Chapter 2-GTR.

8.1.2 The operating mechanism shall be strong, rigid, not subject to rebound.

8.1.3 The mechanism shall be antipumping and trip free (as per IEC definition) under every method of closing.

8.1.4 The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

8.1.5 A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.

8.1.6 Working parts of the mechanism shall be corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

8.1.7 The bidder shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.
8.2 Control:

8.2.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

8.2.2 Each breaker shall be provided with two (2) independent tripping circuits, pressure switches and coils each to be fed from separate DC sources and connected to a different set of protective relays.

8.2.3 The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the Breaker central control cabinet.

8.2.4 The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided on relay panels.

8.2.5 Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated circuits shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage the breaker shall be able to open. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out in the additional information schedules.

8.2.6 Density Monitor contacts and pressure switch contact shall be suitable for direct use as permissive in closing and tripping circuits. The density monitor shall be placed suitably inclined in such a way so that the readings are visible from ground level with or without using binoculars. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciations and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit Breaker.

8.2.7 The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

8.3 Spring operated mechanism:

a) Spring operated mechanism shall be complete with motor in accordance with Chapter 2 -GTR. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.

h) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

9.0 SUPPORT STRUCTURE:

a) The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.

10.0 TERMINAL CONNECTOR PAD:

The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminium and shall be conforming to Australian standard AS-2935 for rated current. The terminal pad shall have protective covers which shall be removed before interconnections.

11.0 INTERPOLE CABELING:

11.1 All cables to be used by contractor shall be armoured and shall be as per IEC-502 (1100 Volts Grade). All cables within & between circuit breaker poles shall be supplied by the CB manufacturer.

11.2 Only stranded conductor shall be used. Minimum size of the conductor for interpole control wiring shall be 1.5 sq.mm. (Copper).

11.3 The cables shall be with oxygen index Min-29 and temp. index as 250°C as per relevant standards.
12.0 FITTINGS AND ACCESSORIES

12.1 Following is a partial list of some of the major fittings and accessories to be furnished by Contractor in the Central Control cabinet. Number and exact location of these parts shall be indicated in the bid.

i) Cable glands (Double compression type), Lugs, Ferrules etc.

ii) Local/remote changeover switch.

iii) Operation Counter

iv) Control switches to cut off control power supply.

v) Fuses as required.

vi) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.

vii) Antipumping relay.

viii) Pole discrepancy relay (for electrically ganged CBs).

ix) D.C. Supervision relays.

xi) Rating and diagram plate in accordance with IEC incorporating year of manufacture.

13.0 ADDITIONAL DATA TO BE FURNISHED:

a) Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b) The temperature v/s pressure curves for each setting of density monitor alongwith details of density monitor.

c) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

d) The effect of non-simultaneity between contacts between poles and also show how it is covered in the guaranteed total break time.

e) Sectional view of non-return couplings if used for SF6 pipes.

f) Details & type of filters used in interrupter assembly and also the operating experience with such filters.

g) Details of SF6 gas:

   i) The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content.
ii) Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas.

h) All duty requirements as applicable to 245 kV & 145 kV CBs specified under Clause 2.0 of this Chapter shall be provided with the support of adequate test reports.

14.0 TESTS:

14.1 In accordance with the requirements stipulated under Chapter 2-GTR the circuit breaker along with its operating mechanism shall conform to IEC:62271-100.

14.2 The test reports of the type tests and the following additional type tests shall also be submitted for Purchaser’s review:

   i) Out of phase closing test as per IEC:62271-100.

   ii) Line charging breaking current for proving parameters as per clause no. 15.9 of this Chapter.

   iii) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure (Ref. Clause 4.1.1).

   iv) Seismic withstand test in unpressurised condition.

   v) Verification of the degree of protection.

   vi) Static Terminal Load test.

   vii) Critical Currents test (if applicable).

14.3 Routine Tests

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

1) Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyser along with necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised. In case of substations where operation analyser is existing the bidder shall utilise the same.
However necessary adopter and transducers etc. if required shall have to be supplied by the bidder.

2) Measurement of Dynamic Contact resistance measurement for arcing & main contacts. Signature of Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts.

15.0 TECHNICAL PARAMETERS:

(In addition to those indicated in Chapter 22-GTR)

I. 245 kV CIRCUIT BREAKER:

A15.1 Rated continuous current (A) at design ambient temperature 1600/2500 (as applicable)

A15.2 Rated short circuit current breaking capacity at rated voltage 40 kA / 50 kA (as applicable) with percentage DC component as per IEC: 62271-100 corresponding to minimum opening time under operating conditions specified.

A15.3 Symmetrical interrupting capability (kArms) 40 / 50 (as applicable)

A15.4 Rated short circuit making current (kAp) 100 / 125 (as applicable)

A15.5 Short time current carrying capability for one second (kArms) 40 / 50 (as applicable)

A15.6 Rated operating duty O-0.3sec-CO-3min-CO cycle

A15.7 Reclosing autoreclosing Single phase & three phase

A15.8 First pole to clear factor 1.3

A15.9 Rated line/cable charging interrupting current at 90 deg. leading power factor angle (A. rms) As per IEC

(The breaker shall be able to interrupt the rated line/cable charging current with test voltage immediately before opening equal to the product of U/C3 & 1.4 as per IEC: 62271-100).

A15.10 Temperature rise over the design ambient temperature As per IEC: 62271-100
A15.11  
i) Total break time as per Cl.3.0 of this Chapter (ms) 65

A15.11  
ii) Rated break time as per IEC (ms) 60

A15.12  Total closing time (ms) Not more than 200

A15.13  Operating mechanism spring

A15.14  Max. difference in the instants of closing/ opening of contacts (ms)

i) Between poles (opening) 3.3

ii) Between poles (closing) 5.0

The above shall be at rated control voltage and rated operating and quenching media pressures.

A15.15  Trip coil and closing coil voltage 220 V DC with variation as specified

A15.16  Noise level at base and upto 50 m (distance from base of breaker) 140 dB (Max.)

A15.17  Rated terminal load calculated As per IEC or as per the value by Chapter 2-GTR, whichever is higher.

A15.18  Auxiliary contacts Besides requirement of specification, the bidder shall wire up 5 NO + 5 NC for future use of purchaser.

A15.19  No of Terminals in common Control cabinet All Contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Purchaser’s use.

II. 145 kV CIRCUIT BREAKER:
B15.1  Rated continuous current(A) at design ambient temperature. 1250

B15.2  Rated short circuit current breaking capacity at rated voltage 31.5 kA with percentage DC component as per IEC: 62271-100 corresponding to minimum opening time under operating conditions specified

B15.3  Symmetrical interrupting capability (kA rms) 31.5
| B15.4  | Rated short circuit making current (kA) | 80 |
| B15.5  | Short time current carrying capability for one second (kA rms) | 31.5 |
| B15.6  | Out of phase breaking current capacity (kA rms) | As per IEC |
| B15.6  | Rated operating duty | O-0.3sec-CO-3min-CO cycle |
| B15.7  | Reclosing phase | Single phase (for Line only) & three Autoreclosing |
| B15.8  | First pole to clear factor | 1.3 |
| B15.9  | Rated line/cable charging interrupting current at 90 deg. leading power factor angle (A. rms) | As per IEC |
|        | (The breaker shall be able to interrupt the rated line/cable charging current with test voltage immediately before opening equal to the product of U/C. 3 & 1.4 as per IEC: 62271-100). |
| B15.10 | Temperature rise over the design ambient temperature | As per IEC: 62271-100 |
| B15.11 | Total break time as per Cl.3.0 of this Chapter (ms) | 65 |
|        | Rated break time as per IEC (ms) | 60 |
| B15.12 | Total closing time (ms) | Not more than 150 |
| B15.13 | Operating mechanism | spring |
| B15.14 | Max. difference in the instants of closing/ opening of contacts (ms) between poles at rated control voltage and rated operating and quenching media pressures. | 3.3 |
| B15.15 | Trip coil and closing coil voltage | 220 V DC with variation as specified |
### B15.16 Noise level at base and upto 50 m (distance from base of breaker)

140 dB (Max.)

### B15.17 Rated terminal load calculated higher.

As per IEC or as per the value by Chapter-GTR, whichever is higher.

### B15.18 Auxiliary contacts

Besides requirement of specification, the bidder shall wire up 5 NO + 5 NC for future use of Purchaser.

### B15.19 No. of Terminals in common control cabinet

All contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Purchaser's use.

## III 33kV VACUUM CIRCUIT BREAKER

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Rated operating duty cycle</td>
<td>0-3min-CO-3 min-CO</td>
</tr>
<tr>
<td>b) First pole to clear factor</td>
<td>1.3</td>
</tr>
<tr>
<td>c) Rated line/cable charging interrupting current at 90 deg. Leading power factor angle (A rms)</td>
<td>As per IEC</td>
</tr>
<tr>
<td>(The breaker shall be able to interrupt the rated line/cable charging current with test voltage immediately before opening equal to the product of U/(root)3 &amp; 1.4 as per IEC – 62271-100)</td>
<td></td>
</tr>
<tr>
<td>e) Rated break-time as per IEC (ms)</td>
<td>45</td>
</tr>
<tr>
<td>f) Total closing time (ms)</td>
<td>Not more than 80</td>
</tr>
<tr>
<td>g) Operating mechanism</td>
<td>Pneumatic/Spring/Hydraulic/or a combination of these</td>
</tr>
<tr>
<td>h) Max. difference in the instants of closing/opening of contacts between poles at rated control voltage and rated operating and quenching media pressures (ms).</td>
<td>3.3</td>
</tr>
<tr>
<td>i) Trip coil &amp; closing coil voltage</td>
<td>250V DC with variation as specified</td>
</tr>
<tr>
<td>j) Noise level at base of CB and upto 50 mtr distance from base of CB.</td>
<td>140 db (max)</td>
</tr>
<tr>
<td>k) Rated terminal load</td>
<td>As per IEC</td>
</tr>
<tr>
<td>l) Auxiliary contacts (Auxiliary switch shall also comply with requirements stipulated under chapter 2 GTR)</td>
<td>Besides requirement of specification, the bidder shall wire up to 5 NO + 5 NC contacts for future use of owner.</td>
</tr>
<tr>
<td>m) No. of Terminals in Common Control cabinet</td>
<td>All Contacts &amp; control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for owner's use.</td>
</tr>
<tr>
<td>n) Rated continuous current at design ambient temperature (amp).</td>
<td>1250/800 (as applicable)</td>
</tr>
<tr>
<td>o) Rated short circuit current breaking capacity at total voltage.</td>
<td>25 KA with percentage DC component as per IEC-62271-100 corresponding to minimum opening time &amp; operating conditions specified.</td>
</tr>
<tr>
<td>p) Symmetrical interrupting capability (KA,rms)</td>
<td>25</td>
</tr>
<tr>
<td>q) Rated short circuit making current (KAP)</td>
<td>As per IEC</td>
</tr>
<tr>
<td>r) Short time current carrying capability for 3 second (KA,rms)</td>
<td>25</td>
</tr>
<tr>
<td>s) Reclosing</td>
<td>Three phase auto reclosing</td>
</tr>
</tbody>
</table>

16.0 PRE-COMMISSIONING TESTS

16.1 An indicative list of tests is given below. All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

(a) Insulation resistance of each pole.
(b) Check adjustments, if any suggested by manufacturer.
(c) Breaker closing and opening time.
(d) Slow and Power closing operation and opening.
(e) Trip free and anti pumping operation.
(f) Minimum pick-up voltage of coils.
(g) Dynamic Contact resistance measurement.
(h) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
(i) Insulation resistance of control circuits, motor etc.
(j) Resistance of closing and tripping coils.
(k) SF6 gas leakage check.
(l) Dew Point Measurement
(m) Operation check of pressure switches and gas density monitor during gas filling.
(n) Checking of mechanical ‘CLOSE’ interlock, wherever applicable.
(o) Resistance measurement of main circuit.
(p) Checking of operating mechanisms
(q) Check for annunciations in control room.
16.2 The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturers representative.
CHAPTER 3 – SWITCHGEAR

ISOLATORS

CONTENTS

<table>
<thead>
<tr>
<th>Clause. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>General:</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Duty Requirements:</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>Constructional Features:</td>
<td>2</td>
</tr>
<tr>
<td>4.0</td>
<td>Earthing Switches:</td>
<td>4</td>
</tr>
<tr>
<td>5.0</td>
<td>Operating Mechanism:</td>
<td>4</td>
</tr>
<tr>
<td>6.0</td>
<td>Operation:</td>
<td>5</td>
</tr>
<tr>
<td>7.0</td>
<td>Terminal Connector Stud/Pad:</td>
<td>6</td>
</tr>
<tr>
<td>8.0</td>
<td>Support Structure:</td>
<td>6</td>
</tr>
<tr>
<td>9.0</td>
<td>Tests:</td>
<td>7</td>
</tr>
<tr>
<td>10.0</td>
<td>Spare Parts And Maintenance Equipment:</td>
<td>7</td>
</tr>
<tr>
<td>11.0</td>
<td>Technical Parameters:</td>
<td>7</td>
</tr>
<tr>
<td>12.0</td>
<td>Pre-Commissioning Tests</td>
<td>10</td>
</tr>
</tbody>
</table>
CHAPTER 3- SWITCHGEAR

ISOLATORS

1.0 GENERAL:

1.1 The Isolators and accessories shall conform in general to IEC: 62271-102 except to the extent explicitly modified in specification and shall be in accordance with requirement of Chapter 2-GTR.

1.2 Isolators shall be outdoor, off-load type. Earth switches shall be provided on isolators wherever called for, with possibility of being mounted on any side of the isolator. 220 kV & below rated isolators shall be double break type, unless specified otherwise.

1.3 Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following:

1.3.1 Isolator assembled with complete Support Insulators, operating rod insulator, base frame, linkages, operating mechanism, control cabinet, interlocks etc.

1.3.2 All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.

1.3.3 The isolator shall be designed for use in the geographic and meteorological conditions as given in Chapter 2-GTR.

2.0 DUTY REQUIREMENTS:

a) Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.

b) The earth switches, wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks. Suitable mechanical arrangement shall also be provided for delinking electrical drive for manual operation.

c) In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of fail safe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in Chapter 2-GTR.

d) The earthing switches shall be capable of discharging trapped charges of the associated lines.
e) The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of isolator on account of make/break operation.

f) Isolator rated for above 72.5 kV shall be of extended mechanical endurance class - M2 as per IEC-62271-102. Isolator rated for 72.5 kV and below shall be of extended mechanical endurance class - M1 as per IEC-62271-102. All earth switches shall be of M0 duty.

3.0 CONSTRUCTIONAL FEATURES:

The features and constructional details of Double Break Isolators, earth switches and accessories shall be in accordance with requirements stated hereunder:

3.1 Contacts:

a) The contacts shall be self aligning and self cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.

b) No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.

c) Contact springs shall not carry any current and shall not loose their characteristics due to heating effects.

d) The moving contact of double break isolator shall have turn-and-twist type or other suitable type of locking arrangement to ensure adequate contact pressure.

3.2 Base:

Each single pole of the isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure.

3.3 Blades:

a) All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. Ferrous parts, other than stainless steel shall not be used in close proximity of main current path. All ferrous castings, if
used elsewhere shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the isolator.

b) The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona rings shall be provided. **Corona shields are not acceptable.** Corona rings shall be made up of aluminum/aluminum alloy.

c) Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.

d) The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals. i.e. after every 1000 operations or after 5 years whichever is earlier.

3.4 **Insulator:**

a) The insulator shall conform to or IEC-60168. The porcelain of the insulator shall conform to the requirements stipulated under Chapter 2-GTR and shall have a minimum cantilever strength of 1000/600 Kgs. for 245/145 kV insulators respectively.

b) Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

c) The parameters of the insulators shall meet the requirements specified under Chapter 2-GTR.

d) Insulator shall be type and routine tested as per IEC-60168.

e) For 245 kV Insulator: (For Isolator)

<table>
<thead>
<tr>
<th>Top PCD</th>
<th>127 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of holes</td>
<td>4 x M16</td>
</tr>
<tr>
<td>Bottom PCD</td>
<td>275 mm</td>
</tr>
<tr>
<td>No. of holes</td>
<td>8 x 18 dia</td>
</tr>
</tbody>
</table>

f) For 145 kV Insulator: (For Isolator)

<table>
<thead>
<tr>
<th>Top PCD</th>
<th>127 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of holes</td>
<td>4 x M16</td>
</tr>
<tr>
<td>Bottom PCD</td>
<td>254 mm</td>
</tr>
<tr>
<td>No. of holes</td>
<td>8 x 18 dia</td>
</tr>
</tbody>
</table>

3.5 **Name Plate:**

The name plate shall conform to the requirements of IEC incorporating year of manufacture.
4.0 EARTHING SWITCHES:

a) Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts.

b) The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.

c) Earthing switches shall be only locally operated.

d) The earthing switches shall be constructionally interlocked with the isolator so that the earthing switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks. Suitable mechanical arrangement shall be provided for de-linking electrical drive for manual operation.

e) Each earth switch shall be provided with flexible copper/aluminum braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade. The transfer of fault current through swivel connection will not be accepted.

f) The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.

g) The frame of each isolator and earthing switches shall be provided with two reliable earth terminals for connection to the earth mat.

h) Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.

i) The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

j) 245 kV earth switches shall also comply with the requirements of IEC-62271-102, in respect of induced current switching duty as defined for Class-B and short circuit making capability class E-0 for earthing switches.

5.0 OPERATING MECHANISM:

a) The bidder shall offer motor operated Isolators and earth switches. Isolators of 36 kV and below and earth switches of 72.5 kV and below rating shall be manual operated.

b) Control cabinet/operating mechanism box shall conform to the requirement stipulated in Chapter 2-GTR and shall be made of cast aluminium/aluminum sheet of adequate thickness (minimum 3 mm).
c) A “Local/Remote” selector switch and a set of open/ close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push buttons.

d) Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

e) Motor shall be an AC motor and conform to the requirements of Chapter 2-GTR.

f) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off. If necessary a quick electromechanical brake shall be fitted on the higher speed shaft to effect rapid braking.

g) Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.

h) Gear should be of forged material suitably chosen to avoid bending/jamming on operation after a prolonged period of non-operation. Also all gear and connected material should be so chosen/surface treated to avoid rusting.

i) The test report for blocked rotor test of motor shall be submitted as per the requirement of clause 23.0 of Chapter 2: GTR of Technical Specification.

j) Only stranded conductor shall be used for wiring. Minimum size of the conductor for control circuit wiring shall be 1.5 sq.mm. (Copper).

k) The operating mechanism shall be located such that it can be directly mounted on any one of the support structure.

6.0 OPERATION:

a) The main Isolator and earth switches shall be gang operated in case of 245 kV, 145 kV & 36kV. However, 245 kV Tandem Isolators shall be individual-pole operated. The operating mechanism of the three poles shall be well synchronized and interlocked.

b) The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator and earth switches shall be provided with “over center” device in the operating mechanism to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

c) Each isolator/pole of isolator and earthswitch shall be provided with a manual operating handle enabling one man to open or close the isolator with ease in one movement while standing at ground level. Non-detachable type manual operating handle shall have provision for padlocking. For detachable type manual operating handles, suitable provision shall be
made inside the operating mechanism box for parking the detached handles. The provision of manual operation shall be located at a convenient operating height from the base of isolator support structure.

d) The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator. Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods/ pipes shall be provided with suitable universal couplings to account for any angular misalignment.

e) All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rust proof.

f) Signaling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signaling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.

g) The position of movable contact system (main blades) of each of the Isolators and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the Isolators and earthing switch. The indicator shall be of metal and shall be visible from operating level.

h) The contractor shall furnish the following details along with quality norms, during detailed engineering stage.

   (i) Current transfer arrangement from main blades of isolator along with milli volt drop immediately across transfer point.

   (ii) Details to demonstrate smooth transfer of rotary motion from motor shaft to the insulator along with stoppers to prevent over travel.

7.0 TERMINAL CONNECTOR STUD/PAD:

The isolator terminal pads/studs shall be made of high quality copper or aluminium and shall be conforming to Australian standard AS-2935 for rated current. The terminal pad shall have protective covers which shall be removed before interconnections.

8.0 SUPPORT STRUCTURE:
245 kV/145/36 kV Isolators shall be suitable for mounting on support structures to be supplied in accordance with stipulations of Chapter 2-GTR.

9.0 TESTS:

9.1 In continuation to the requirements stipulated under Chapter 2-GTR the isolator along with its earthing switch and operating mechanism should have been type tested as per IEC and shall be subjected to routine tests in accordance with IEC-62271-102. Minimum 1000 Nos. mechanical operations in line with mechanical endurance test, M0 duty, shall be carried out on 1 (one) isolator out of every lot of isolators, assembled completely with all accessories, as acceptance test for the lot. The travel characteristics measured at a suitable location in the base of isolator along with motor current/power drawn, during the entire travel duration are to be recorded at the start and completion and shall not vary by more than (+/-) 10% after completion of 1000 cycles of operation. After completion of test, mechanical interlock operation to be checked.

9.2 The test reports of the type tests and the following additional type tests (additional type tests are required for isolators rated above 72.5 kV only) shall also be submitted for the Purchaser’s review.

(i) Radio interference voltage test.

(ii) Seismic withstand test on isolator mounted on Support structure. The test shall be performed in the following position:

<table>
<thead>
<tr>
<th>Isolator state</th>
<th>E/S state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolator open</td>
<td>E/S Closed</td>
</tr>
<tr>
<td>Isolator open</td>
<td>E/S Open</td>
</tr>
<tr>
<td>Isolator closed</td>
<td>E/S Open</td>
</tr>
</tbody>
</table>

10.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

Bidder shall include in his proposal mandatory spare parts in accordance with the requirements stipulated in Chapter 1 - PSR.

11.0 TECHNICAL PARAMETERS:
(In addition to those specified under Chapter 2-GTR)

I. 245 kV ISOLATORS:

A11.1 Type          Outdoor
A11.2 Rated current at 50° C ambient temperature 1600A / 2500 A (As applicable).
A11.3  Rated short time withstand current of isolator and earth switch (for 1 Sec.)

40 kA/ 50 kA (as applicable)

A11.4  Rated dynamic short circuit withstand current of isolator and earth switch

100 kAp / 125 kAp (as applicable)

A11.5  Temperature rise over design ambient temperature

As per table V of IEC-694.

A11.6  Rated mechanical or terminal load

As per table III of IEC-62271-102 as per value calculated in Chapter 2-GTR whichever is higher.

A11.7  Operating mechanism of isolator/earth switch

A.C. Motor operated

A11.8  No. of auxiliary contacts on each isolator

Besides requirement of this spec., the bidder shall wire up 5 NO + 5 NC to TBs (Reversible) for Purchaser’s future use.

A11.9  No. of auxiliary contacts on each earthing switch

Besides requirement of this spec., the bidder shall wire up 3 NO + 3 NC to TBs (Reversible) for Purchaser’s future use.

A11.10 Operating time

15 sec. or less

A11.11 Number of terminal in control cabinet (Interpole cabling shall be supplied by Contractor)

All contacts & control circuits are to be wired up to control cabinet plus 24 spare terminals evenly distributed.

II. 145 kV ISOLATORS:

B11.1  Type

Outdoor

B11.2  Rated current at 50°C ambient temperature

1250 A

B11.3  Rated short time withstand current of isolator and earth switch

31.5 kA for 1 Sec.

B11.4  Rated dynamic short circuit withstand current of isolator and earth switch

80 kAp
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>B11.5</td>
<td>Temperature rise over design ambient temperature</td>
<td>As per table V of IEC-694.</td>
</tr>
<tr>
<td>B11.6</td>
<td>Rated mechanical terminal load</td>
<td>As per table III of IEC-62271-102 as per value calculated in Chapter 2-GTR whichever is higher.</td>
</tr>
<tr>
<td>B11.7</td>
<td>Operating mechanism of isolator/earth switch</td>
<td>A.C. Motor operated</td>
</tr>
<tr>
<td>C11.8</td>
<td>No. of auxiliary contacts on each isolator</td>
<td>Besides requirement of this spec., 5 NO + 5 NC to contacts, wired to terminal block exclusively for Purchaser’s use in future.</td>
</tr>
<tr>
<td>B11.9</td>
<td>No. of auxiliary contacts on each earthing switch</td>
<td>Besides requirement of this spec., the bidder shall wire up 3 NO + 3 NC to TBs (Reversible) for Purchaser’s future use.</td>
</tr>
<tr>
<td>B11.10</td>
<td>Operating time</td>
<td>15 sec. or less</td>
</tr>
<tr>
<td>B11.11</td>
<td>Number of terminal in control cabinet plus (Interpole cabling shall be supplied by Contractor)</td>
<td>All contacts &amp; control circuits are to be wired upto control cabinet 24 spare terminals evenly distributed.</td>
</tr>
</tbody>
</table>

**III. 33kV ISOLATOR**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>C11.1</td>
<td>Type</td>
<td>Outdoor (Double Break)</td>
</tr>
<tr>
<td>C11.2</td>
<td>Temperature rise over design ambient temperature</td>
<td>As per table V of IEC 62271-1</td>
</tr>
<tr>
<td>C11.3</td>
<td>Rated mechanical terminal load</td>
<td>As per table-III of IEC 62271-102 IEC 129(1984) or as per value calculated in Chapter 2-GTR whichever is higher</td>
</tr>
<tr>
<td>C11.4</td>
<td>Number of terminals in control cabinet (Interpole cabling shall be supplied by contractor)</td>
<td>All contacts and control circuits are to be wired upto control cabinet plus 24 terminals exclusively for Owner’s use.</td>
</tr>
<tr>
<td>C11.5</td>
<td>Rated current at design</td>
<td>1250/800 Amps(as applicable).</td>
</tr>
</tbody>
</table>
ambient temperature

C11.6 Rated short time withstand current of isolator and earthswitch 25 kA for 3 Sec

C11.7 Rated dynamic short circuit withstand current of isolator and earth switch As per IEC

C11.8 Operating mechanism for Isolator and Earth switch Manual

C11.9 No. of auxiliary contacts on each isolator 5 NO + 5 NC contacts, wired to terminal block exclusively for Owner's use in future.

C11.10 No. of auxiliary contacts on each earthing switch 3 NO + 3 NC contacts wired to terminal block exclusively for Owner's use in future.

C.I The porcelain of the 36 kV insulators shall have minimum cantilever strength of 450 KGS

C.II 33 kV Isolator shall be gang operated for main blades and earth switches.

12.0 PRE-COMMISSIONING TESTS

12.1 An indicative list of tests on isolator and earthswitch is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance of each pole.

(b) Manual and electrical operation and interlocks.

(c) Insulation resistance of control circuits and motors.

(d) Ground connections.

(e) Contact resistance.

(f) Proper alignment so as to minimize vibration during operation.

(g) Measurement of operating Torque for isolator and Earth switch.

(h) Resistance of operating and interlocks coils.
(i) Functional check of the control schematic and electrical & mechanical interlocks.

(j) 50 operations test on isolator and earth switch.

12.2 The contractor shall ensure that erection, testing and commissioning of isolators above 72.5 kV class shall be carried out under the supervision of the isolator manufacturer's representative. The commissioning report shall be signed by the manufacturer's representative.
CHAPTER 3: SWITCHGEAR
INSTRUMENT TRANSFORMERS

CONTENTS

Clause.No.  Description                                             Page No.
1.0         GENERAL:                                               1
2.0         CONSTRUCTION FEATURES:                                1
3.0         CURRENT TRANSFORMERS:                                 2
4.0         VOLTAGE TRANSFORMERS:                                 4
5.0         TERMINAL CONNECTORS:                                 5
6.0         TESTS:                                                5
7.0         SPARE PARTS AND MAINTENANCE EQUIPMENT:                7
8.0         TECHNICAL PARAMETERS:                                7
9.0         PRE-COMMISSIONING TESTS                               10
Table-IA   REQUIREMENTS OF 245 KV VOLTAGE TRANSFORMERS          12
Table-IB   REQUIREMENTS OF 145 KV CAPACITIVE VOLTAGE TRANSFORMERS 13
Table-IC   REQUIREMENTS OF 33 KV POTENTIAL TRANSFORMERS          14
Table-IIA  REQUIREMENTS FOR 245 KV CURRENT TRANSFORMERS         15
Table-IIB  REQUIREMENTS FOR 145 KV CURRENT TRANSFORMERS         16
Table-IIIC  REQUIREMENTS FOR 145 kV CURRENT TRANSFORMERS        17
Table-IIID  REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS         18
Table-IIIE  REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS         Error!

Bookmark not defined.
CHAPTER 3 - SWITCHGEAR

INSTRUMENT TRANSFORMERS

1.0 GENERAL:

1.1 The instrument transformers and accessories shall conform to the latest version of the standards specified below except to the extent explicitly modified in the specification and shall be in accordance with the requirements in Chapter 2-GTR.

Current Transformers IEC: 60044-1
Capacitive Voltage Transformers IEC:60044-5 / IEC-60358
Inductive Voltage Transformers IEC:60044-2

1.2 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.

1.3 The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per Chapter 2-GTR.

1.4 The impregnation details alongwith tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

1.5 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Chapter 2-GTR.

2.0 CONSTRUCTION FEATURES:

The features and constructional details of instrument transformers shall be in accordance with requirements stipulated hereunder:

2.1 a) Instrument transformers shall be of 245/145 kV class, oil filled/ SF6 gas filled, suitable for outdoor service and upright mounting on steel structures. 245/145 kV Instrument transformers shall be with shedded porcelain/ polymer bushings/Insulators

b) Bushings/Insulators shall conform to requirements stipulated in Section-GTR. The bushing/insulator for CT shall be one piece without any metallic flange joint.

c) Oil filling and drain plugs, oil sight glass shall be provided for CT and for electromagnetic unit of CVT etc. The Instrument transformer shall have cantilever strength of not less than 350 kg and 350 kg respectively for 245kV and 145 kV Instrument transformers. For CVT with polymer housing, the cantilever strength shall not be less than 150kg. Oil filling and drain plugs are not required with SF6 gas filled CT.

d) Instruments transformers shall be hermetically sealed units. Bidder/Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers during detailed engineering.

Bidder/Manufacturer shall also furnish the details of site tests to check the effectiveness of hermetic sealing for approval.
e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

f) In case of SF<sub>6</sub> filled CTs/Inductive VTs, it shall be provided with a suitable SF<sub>6</sub> gas density monitoring device, with NO/NC contacts to facilitate the remote annunciation and tripping in case of SF<sub>6</sub> leakage. Provisions shall be made for online gas filling. Suitable rupture disc shall be provided to prevent explosion.

2.2 Terminal box/Marshalling Box:
Terminal box shall conform to the requirements of Chapter 2-GTR.

2.3 Insulating Oil:

a) Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IEC - 60296 (required for first filling). Non–PCB based synthetic insulating oil conforming to IEC 60867 can also be used in the capacitor units of CVT with specific approval from the owner, the proposal for which shall be submitted during detailed engineering stage.

b) The SF6 gas shall comply with IEC-60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under operating conditions.

2.4 Name Plate:

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers and rated voltage, voltage factor in case of voltage transformers shall be clearly indicated on the name plate. The rated thermal current in case of CT shall also be marked on the name plate.

The intermediate voltage in case of capacitor voltage transformer shall be indicated on the name plate.

3.0 CURRENT TRANSFORMERS:

a) Current transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. PF Terminal for measurement of tan delta and capacitance of the unit shall be provided. These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminal box. In case “Bar primary” inverted type current transformers are offered the manufacturer will meet following additional requirements:

(i) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.

(ii) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.

(iii) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.
(iv) Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.

(v) Bidder/Manufacturer shall recommend whether any special storage facility is required for spare CT.

b) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.

c) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT parameters.

d) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.

e) Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.

f) Current transformer’s guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

g) For 245/145 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Chapter 1 – GTS.

h) For 245/145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

i) The current transformer shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit. The Contractor shall submit the details of packing design to the Purchaser for review.

j) For 245/145 kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the central marshalling box suitably wired upto the terminal blocks.

k) The wiring diagram plate for the interconnections of the three single phase CTs shall be provided inside the marshalling box. A typical wiring diagram No. 0000-000-T-E-L-028 (Sh. 1 & 2) is enclosed herewith to be followed by the Bidder/Manufacturer.

l) The current transformers should be suitable for mounting on lattice support structure or pipe structure to be provided by the Contractor in accordance with stipulations of Chapter 2-GTR.
m) The CT shall be so designed as to achieve the minimum risks of explosion in service. Bidder/Manufacturer shall bring out in his offer, the measures taken to achieve this.

n) 245/145 kV current transformers shall be suitable for high speed auto reclosing.

4.0 VOLTAGE TRANSFORMERS:

a) 245/145 kV Voltage transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling. 36kV Voltage transformers shall be Inductive Type.

b) Voltage transformers secondaries shall be protected by HRC cartridge type fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VTs shall be terminated to the stud type non-disconnecting terminal blocks in the individual phase secondary boxes via the fuse.

c) VTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. Carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 KHz. Details of the arrangement shall be furnished along with the bid. H.F. terminal of the VT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilised. Further, earthing link with fastener to be provided for HF terminal.

d) The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.

e) The damping device, which should be permanently connected to one of the secondary windings, should be capable of suppressing the ferroresonance oscillations.

f) The accuracy of 0.2 on secondary III for all VTs should be maintained through out the entire burden range upto 50 VA on all the windings without any adjustments during operation.

g) 245/145 kV VTs shall be suitable for mounting on tubular GI pipe in accordance with stipulations of Chapter 2-GTR.

h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

i) A protective surge arrester shall be provided if required, to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, bidder shall bring out the details in the bid.

j) The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does
not deteriorate with time. A typical wiring diagram no. : 0000-000-T-E-L-029 is enclosed herewith to be followed by the Bidder/Manufacturer.

5.0 TERMINAL CONNECTORS:

The terminal connectors shall meet the requirements as given in Chapter 2-GTR.

6.0 TESTS:

6.1 In accordance with the requirements in Section-GTR, Current and Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with IEC:60044-1 and IEC: 60044-5/60044-2 respectively.

6.2 The test reports of the type tests and the following additional type tests (additional type tests are required for Instrument Transformers, rated above 72.5 kV only) shall also be submitted for the Purchaser’s review.

a) Current Transformers:

i) Radio interference voltage test as per IEC 60044-1.

ii) Seismic withstand test.

iii) Thermal stability test, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit. (not applicable for SF6 filled CT)

iv) Thermal co-efficient test i.e. measurement of tan delta as a function of temperature (at ambient and between 80°C & 90°C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um) (not applicable for SF6 filled CT)

v) The current transformer shall be subjected to Multiple chopped impulse test (not applicable for SF6 filled CT) by any one of the following two methods given below to assess the CT performance in service to withstand the high frequency over voltage generated due to closing & opening operation of isolators. Alternatively, method as per IEC:60044-1 may be followed:

Method I: 600 negative polarity lightning impulses chopped on crest will be applied to current transformer. The opposite polarity amplitude must be limited to 50% of crest value when the wave is chopped. One impulse per minute shall be applied and every 50 impulse high frequency currents form the windings and total current to earth will be recorded and be compared with reference currents recorded applying one or more (max 20) reduced chopped impulses of 50% of test value.

Oil samples will be taken before and 3 days after the test. Gas analysis must not show appreciable rate of increase in various gases related with the results of the analysis performed before test.

Total sum of crest values of current through secondaries must not exceed 5% of the crest value of total current to earth.

CT must withstand dielectric tests after this test to pass the test.
**Method II:** 100 negative polarity impulses with a rise and fall time of less than 0.25 microsecond corrected to atmospheric condition shall be applied at one minute interval and total current through insulation of earth will be recorded. The amplitude of first opposite polarity should be limited to 50% of the chopped impulse crest value. Voltage and total current wave shapes shall be recorded after every 10 impulses, and will be compared with reference wave shapes recorded before test at 50% of test values.

Oil sample shall be taken before and 3 days after the test and CT shall be deemed to have passed the test if the increase in gas content before and after test is not appreciable.

b) **Voltage transformers:**

i) High frequency capacitance and equivalent series resistance measurement (as per IEC-60358) for CVT.

ii) Seismic withstand test.

iii) Stray capacitance and stray conductance measurement of the low voltage terminal (as per IEC-60358) for CVT.

iv) Determination of temperature coefficient test (as per IEC-60358).

v) Radio interference voltage test as per IEC-60044-5/IEC-60044-2. However the RIV level shall be as specified in clause Major Technical Parameters in Section-GTR.

vi) Apart from the above, report of all special tests mentioned in IEC-60044-5 for Capacitive voltage transformer shall also be submitted for approval.

6.3 The current and voltage transformer shall be subjected to the following routine tests in addition to routine tests as per IEC.

a) **CURRENT TRANSFORMERS:**

**ROUTINE TESTS:**

for Oil filled CTs

i) Measurement of Capacitance.

ii) Oil leakage test.

iii) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 Um/\sqrt{3}.

for SF6 filled CTs

i) Dew point measurement

ii) SF6 alarm/ lockout check.

iii) SF6 leakage test. Gas leakage rate shall be maintained within 0.2% per annum.
b) **VOLTAGE TRANSFORMERS:**

Routine tests on Capacitive voltage transformer shall be done in line with IEC-60044-5.

### 7.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

The Bidder shall include in his proposal spare parts equipment in accordance with Section-Project.

### 8.0 TECHNICAL PARAMETERS:

#### A. 245 kV CURRENT TRANSFORMERS:

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>A8.1 Rated Primary current</td>
<td>1600 A</td>
</tr>
<tr>
<td>A8.2 Rated short time thermal current</td>
<td>40 kA for 1 sec/50 kA for 1 sec. (as applicable)</td>
</tr>
<tr>
<td>A8.3 Rated dynamic current kA (peak)</td>
<td>100 / 125 (as applicable)</td>
</tr>
<tr>
<td>A8.4 Maximum temperature rise over design ambient temperature</td>
<td>As per IEC:60044-1</td>
</tr>
<tr>
<td>A8.5 One minute power frequency withstand voltage sec. terminal &amp; earth</td>
<td>5 kV</td>
</tr>
<tr>
<td>A8.6 Number of terminals</td>
<td>All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.</td>
</tr>
<tr>
<td>A8.7 Type of insulation</td>
<td>Class A</td>
</tr>
</tbody>
</table>

Current transformers shall also comply with requirements of Table - IIA.

#### B. 145 kV CURRENT TRANSFORMERS:

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>B8.1 Rated Primary current</td>
<td>-1250 A</td>
</tr>
<tr>
<td>B8.2 Rated short time thermal current</td>
<td>31.5 kA for 1 sec.</td>
</tr>
<tr>
<td>B8.3 Rated dynamic current</td>
<td>80 kA (peak)</td>
</tr>
<tr>
<td>B8.4 Maximum temperature rise over design ambient temperature</td>
<td>As per IEC:60044-1</td>
</tr>
<tr>
<td>B8.5 One minute power frequency withstand voltage sec. terminal &amp; earth</td>
<td>5 kV</td>
</tr>
<tr>
<td>B8.6 Number of terminals</td>
<td>All terminals of control circuits are to be wired upto marshaling box</td>
</tr>
</tbody>
</table>
plus 20% spare terminals evenly distributed on all TBs.

**B8.7 Type of insulation**

Class A

Current transformers shall also comply with requirements of Table – IIB/ or IIC as applicable.

**C. 33 kV CURRENT TRANSFORMERS:**

<table>
<thead>
<tr>
<th>C8.1</th>
<th>Rated Primary current</th>
<th>600/1200A (as applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8.2</td>
<td>Rated Extended Primary current</td>
<td>120% (on all cores)</td>
</tr>
<tr>
<td>C8.3</td>
<td>Rated short time thermal Current</td>
<td>25 kA for 3 sec.</td>
</tr>
<tr>
<td>C8.4</td>
<td>Rated dynamic current</td>
<td>As per IEC</td>
</tr>
<tr>
<td>C8.5</td>
<td>Maximum temperature rise over design ambient Temperature</td>
<td>As per IEC:44-1</td>
</tr>
<tr>
<td>C8.6</td>
<td>One minute power frequency with stand voltage sec. terminal &amp; earth</td>
<td>5 kV</td>
</tr>
<tr>
<td>C8.7</td>
<td>Number of terminals</td>
<td>All terminals of control circuits are to be wired upto marshaling box plus 20% spare terminals evenly distributed on all TBs.</td>
</tr>
<tr>
<td>C8.8</td>
<td>Type of insulation</td>
<td>Class A</td>
</tr>
</tbody>
</table>

Current transformers shall also comply with requirements of Table IID/IIE as applicable.

**D. 245 KV VOLTAGE TRANSFORMERS:**

<table>
<thead>
<tr>
<th>D8.1</th>
<th>System fault level (for 1 second)</th>
<th>40 kA / 50 kA (as applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8.2</td>
<td>Standard reference range of frequencies for which the accuracies are valid</td>
<td>96% to 102% for protection and 99% to 101% for measurement</td>
</tr>
<tr>
<td>D8.3</td>
<td>High frequency capacitance carrier frequency range</td>
<td>Within 80% to 150% of rated for entire capacitance (for CVT only)</td>
</tr>
<tr>
<td>D8.4</td>
<td>Equivalent series resistance over the entire carrier frequency range</td>
<td>Less than 40 ohms (for CVT only)</td>
</tr>
</tbody>
</table>
D8.5 Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range

As per IEC:358 (for CVT only)

D8.6 One minute power frequency withstand voltage:

i) Between LV (HF) terminal and earth terminal

10 kV (rms) for exposed terminals and 4 kV (rms) for terminals enclosed in a weather proof box

ii) For secondary winding

3 kV (rms)

D8.7 Maximum temperature rise over design ambient temperature

As per IEC:60044-2 or 60044-5

D8.8 Number of terminals in control cabinet (interpole cabling is to be supplied by Purchaser)

All terminals are wired upto marshaling box plus 12 terminals exclusively for Purchaser’s use.

D8.9 Rated Total Thermal burden (VA)

300 (100VA/winding)

Voltage Transformers shall also comply with the requirements of Table-IA of this Section.

E. 145 KV VOLTAGE TRANSFORMERS:

E8.1 System fault level

31.5 kA for 1 second

E8.2 Standard reference range of frequencies for which the accuracies are valid

96% to 102% for protection and 99% to 101% for measurement

E8.3 High frequency capacitance for entire carrier frequency range

Within 80% to 150% of rated capacitance (for CVT only)

E8.4 Equivalent series resistance over the entire carrier frequency range

Less than 40 ohms (for CVT only)

E8.5 Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range

As per IEC:358 (for CVT only)

E8.6 One minute power frequency withstand voltage:

i) Between LV (HF) terminal and earth terminal

For secondary winding

10 kV (rms) for exposed terminals and 4 kV (rms) for terminals enclosed in a weather proof box

3 kV (rms)
E8.7 Maximum temperature rise over design ambient temperature  As per IEC:60044-2 or 60044-5

E8.8 Number of terminals in control cabinet (interpole pole cabling is to be supplied by Purchaser)  All terminals are wired up to marshaling box plus 12 terminals exclusively for Purchaser’s use.

E8.9 Rated Total Thermal burden (VA)  300 (100VA/winding)

Voltage Transformers shall also comply with the requirements of Table-IB of this Section.

F. 33 kV POTENTIAL TRANSFORMERS

F8.1 System Fault level  25kA for 3 sec

F8.2 Standard reference range of frequencies for which the Accuracies are valid 96% to 102% for protection and 99% to 102% for measurement

F8.3 One minute power frequency Withstand voltage:
   i) Between LV terminal and earth terminal  10kVrms for exposed terminals and 4kVrms for terminals enclosed in a weather proof box.
   ii) For secondary winding  2 kVrms

F8.4 Maximum temperature rise over design ambient temperature  As per IEC 186

F8.5 Number of terminals in control Cabinet  All terminals of control circuits are wired up to marshalling box Plus spare 20% terminals evenly distributed on all TBs

F8.6 Rated total thermal burden  75 VA

Voltage Transformers shall also comply with the requirements of Table-IC of this Section

9.0 PRE-COMMISSIONING TESTS

9.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

9.2 Current Transformers
   (a) Insulation Resistance Test for primary and secondary.
(b) Polarity test

(c) Ratio identification test - checking of all ratios on all cores by primary injection of current.

(d) Dielectric test of oil (wherever applicable).

(e) Magnetizing characteristics test.

(f) Tan delta and capacitance measurement

(g) Secondary winding resistance measurement

(h) Contact resistance measurement (wherever possible/accessible).

(i) Test for SF6 (for SF6 filled CTs) – Dew point measurement, SF6 alarm/lockout check.

(j) DGA test of oil.

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere. Bidder/Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Bidder/Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

9.3 Voltage Transformers/Capacitive Voltage Transformers

(a) Insulation Resistance test for primary (if applicable) and secondary winding.

(b) Polarity test

(c) Ratio test

(d) Dielectric test of oil (wherever applicable).

(e) Tan delta and capacitance measurement of individual capacitor stacks.

(f) Secondary winding resistance measurement.
### Table-IA  REQUIREMENTS OF 245 KV VOLTAGE TRANSFORMERS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PARTICULAR</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated primary voltage (kV rms)</td>
<td>245</td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
<td>Single phase capacitor VT</td>
</tr>
<tr>
<td>3.</td>
<td>No. of secondaries</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Rated voltage factor</td>
<td>1.2 continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 - 30 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Phase angle error</td>
<td>± 10 minutes (For metering core)</td>
</tr>
<tr>
<td>6.</td>
<td>Capacitance (pf)</td>
<td>4400/8800  + 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(As applicable) - 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Secondary I Secondary II Secondary III</td>
</tr>
<tr>
<td>7.</td>
<td>Voltage Ratio</td>
<td>220/0.11 220/0.11 220/0.11</td>
</tr>
<tr>
<td>8.</td>
<td>Application</td>
<td>Protection Protection Metering</td>
</tr>
<tr>
<td>9.</td>
<td>Accuracy</td>
<td>3 P 3 P 0.2</td>
</tr>
<tr>
<td>10.</td>
<td>Output burden (VA) (minimum)</td>
<td>50 50 50</td>
</tr>
</tbody>
</table>
### Table-IB REQUIREMENTS OF 145 KV CAPACITIVE VOLTAGE TRANSFORMERS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PARTICULAR</th>
<th>145</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated primary voltage (kV rms)</td>
<td>145</td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
<td>Single phase capacitor VT</td>
</tr>
<tr>
<td>3.</td>
<td>No. of secondaries</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Rated voltage factor</td>
<td>1.2 continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 - 30 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Phase angle error</td>
<td>± 10 minutes (For metering core)</td>
</tr>
<tr>
<td>6.</td>
<td>Capacitance (pf)</td>
<td>8800 + 10%/-5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Secondary I Secondary II Secondary III</td>
</tr>
<tr>
<td>7.</td>
<td>Voltage Ratio</td>
<td>132/0.11 Secondary I 132/0.11 Secondary II 132/0.11 Secondary III</td>
</tr>
<tr>
<td>8.</td>
<td>Application</td>
<td>Protection Protection Metering</td>
</tr>
<tr>
<td>9.</td>
<td>Accuracy</td>
<td>3 P 3 P 0.2</td>
</tr>
<tr>
<td>10.</td>
<td>Output burden (VA) (minimum)</td>
<td>50 50 50</td>
</tr>
</tbody>
</table>
### Table-IC  REQUIREMENTS OF 33 KV POTENTIAL TRANSFORMERS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PARTICULAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated primary voltage (kV rms)</td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
</tr>
<tr>
<td>3.</td>
<td>No. of secondaries</td>
</tr>
<tr>
<td>4.</td>
<td>Rated voltage factor</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Phase angle error</td>
</tr>
<tr>
<td>6.</td>
<td>Standard reference range of frequencies for which the Accuracies are valid</td>
</tr>
<tr>
<td>7.</td>
<td>One minute power frequency Withstand voltage:</td>
</tr>
<tr>
<td></td>
<td>i) Between LV terminal and earth earth terminal</td>
</tr>
<tr>
<td></td>
<td>ii) For secondarywinding</td>
</tr>
<tr>
<td>8.</td>
<td>Maximum temperature rise over design ambient temperature</td>
</tr>
<tr>
<td>9.</td>
<td>Number of terminals in control Cabinet</td>
</tr>
<tr>
<td>10.</td>
<td>Rated total thermal burden</td>
</tr>
<tr>
<td>11.</td>
<td>Voltage Ratio</td>
</tr>
<tr>
<td>12.</td>
<td>Application</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Accuracy</td>
</tr>
<tr>
<td>14.</td>
<td>Output burden (VA) (minimum)</td>
</tr>
</tbody>
</table>

ICB/PMD/MCTLP/017/18-01  Procurement of plant  Single-Stage, Two-Envelope  Page 14 of 18
### Table-IIA

**REQUIREMENTS FOR 245 KV CURRENT TRANSFORMERS**

<table>
<thead>
<tr>
<th>No.of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output burden (VA)</th>
<th>Accuracy class as per IEC: 44-1</th>
<th>Min. knee pt. voltage (V)</th>
<th>Max. CT sec.wdg. resistance (ohms)</th>
<th>Max. Excitation current at Vk (in mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>1600-800/1</td>
<td>-</td>
<td>1600/800</td>
<td>8/4</td>
<td>25 on 1600/1 Tap; 50 on 800/1 Tap</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>BUS DIFF MAIN</td>
<td>1600-800/1</td>
<td>-</td>
<td>1600/800</td>
<td>8/4</td>
<td>25 on 1600/1 Tap; 50 on 800/1 Tap</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>METERING</td>
<td>1600-800/1</td>
<td>20</td>
<td>0.2S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>TRANS. BACK UP/LINE PROTN.</td>
<td>1600-800/1</td>
<td>-</td>
<td>1600/800</td>
<td>8/4</td>
<td>25 on 1600/1 Tap; 50 on 800/1 Tap</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>TRANS. DIFF/LINE PROTN.</td>
<td>1600-800/1</td>
<td>-</td>
<td>1600/800</td>
<td>8/4</td>
<td>25 on 1600/1 Tap; 50 on 800/1 Tap</td>
<td></td>
</tr>
</tbody>
</table>

All relaying CTs shall be of accuracy class TPS as per IEC 60044-1
## Table-IIB

### REQUIREMENTS FOR 145 KV CURRENT TRANSFORMERS

<table>
<thead>
<tr>
<th>No. of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output burden (VA)</th>
<th>Accuracy class as per IEC: 44-1</th>
<th>Min. knee pt. voltage Vk</th>
<th>Max. CT sec.wdg. resistance (ohms)</th>
<th>Max. Excitation current at Vk</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>1200-600/1</td>
<td>-</td>
<td>1200/600</td>
<td>12/6</td>
<td>25 on 1200/1 Tap; 50 on 600/1 Tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>BUS DIFF MAIN</td>
<td>1200-600/1</td>
<td>-</td>
<td>1200/600</td>
<td>12/6</td>
<td>25 on 1200/1 Tap; 50 on 600/1 Tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>METERING</td>
<td>1200-600/1</td>
<td>20</td>
<td>0.2S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>TRANS. BACK UP/LINE PROTN.</td>
<td>1200-600/1</td>
<td>-</td>
<td>1200/600</td>
<td>12/6</td>
<td>25 on 1200/1 Tap; 50 on 600/1 Tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>TRANS. DIFF/LINE PROTN.</td>
<td>1200-600/1</td>
<td>-</td>
<td>1200/600</td>
<td>12/6</td>
<td>25 on 1200/1 Tap; 50 on 600/1 Tap</td>
<td></td>
</tr>
</tbody>
</table>

All relaying CTs shall be of accuracy class T PS as per IEC 60044-1.
## Table-IIIC
REQUIREMENTS FOR 145 kV CURRENT TRANSFORMERS

<table>
<thead>
<tr>
<th>No.of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Core No.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output burden (VA)</th>
<th>Accuracy class as per IEC: 44-1</th>
<th>Min. knee pt. voltage Vk</th>
<th>Max. CT sec. wg. resistance (ohms)</th>
<th>Max. Excitation current at Vk (in mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>600-300/1</td>
<td>-</td>
<td>600/300</td>
<td>600/300</td>
<td>6/3</td>
<td>30 on 600/1 Tap; 60 on 300/1 Tap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>BUS DIFF MAIN</td>
<td>600-300/1</td>
<td>-</td>
<td>600/300</td>
<td>600/300</td>
<td>6/3</td>
<td>30 on 600/1 Tap; on 300/1 Tap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>METERING</td>
<td>300-150/1</td>
<td>20</td>
<td>0.2S</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>TRANS. BACK UP/LINE PROTN.</td>
<td>600-300/1</td>
<td>-</td>
<td>600/300</td>
<td>600/300</td>
<td>6/3</td>
<td>30 on 600/1 Tap; 60 on 300/1 Tap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>TRANS. DIFF/LINE PROTN.</td>
<td>600-300/1</td>
<td>-</td>
<td>600/300</td>
<td>600/300</td>
<td>6/3</td>
<td>30 on 600/1 Tap; 60 on 300/1 Tap</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All relaying CTs shall be of accuracy class TPS as per IEC 60044-1.
### REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS

#### Current Transformer (600A)

<table>
<thead>
<tr>
<th>No.of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output burden (VA)</th>
<th>Accuracy class as per IEC: 44-1</th>
<th>Min. knee pt. voltage Vk</th>
<th>Max. CT sec. wdg. resistance (ohms)</th>
<th>Max. Excitation current at Vk</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>O/C &amp; E/F</td>
<td>400-200/1</td>
<td>-</td>
<td>T.P.S.</td>
<td>600/300</td>
<td>4/2</td>
<td>40 on 400/1 Tap; 80 on 200/1 Tap</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>METERING</td>
<td>400-200/100/1</td>
<td>20</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

All relaying CTs shall be of accuracy class PS as per IEC 60044-1.

#### Current Transformer (1200A)

<table>
<thead>
<tr>
<th>No.of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output burden (VA)</th>
<th>Accuracy class as per IEC: 44-1</th>
<th>Min. knee pt. voltage Vk</th>
<th>Max. CT sec. wdg. resistance (ohms)</th>
<th>Max. Excitation current at Vk</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>O/C &amp; E/F</td>
<td>1200-600/1</td>
<td>-</td>
<td>T.P.S.</td>
<td>1200/600</td>
<td>12/6</td>
<td>30 on 1200/1 Tap; 60 on 600/1 Tap</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>METERING</td>
<td>1200-600/1</td>
<td>30</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>TRANS. DIFF PROTN</td>
<td>1200-600/1</td>
<td>-</td>
<td>T. P.S.</td>
<td>1200/600</td>
<td>12/6</td>
<td>30 on 1000/1 Tap; 60 on 500/1 Tap</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## CHAPTER 3 - SWITCHGEAR

### SURGE ARRESTERS

#### CONTENTS

<table>
<thead>
<tr>
<th>Clause.No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL:</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>DUTY REQUIREMENTS:</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>CONSTRUCTIONAL FEATURES:</td>
<td>2</td>
</tr>
<tr>
<td>4.0</td>
<td>FITTINGS AND ACCESSORIES:</td>
<td>3</td>
</tr>
<tr>
<td>5.0</td>
<td>TESTS:</td>
<td>4</td>
</tr>
<tr>
<td>6.0</td>
<td>SPARE PARTS AND MAINTENANCE EQUIPMENT:</td>
<td>5</td>
</tr>
<tr>
<td>7.0</td>
<td>TECHNICAL PARAMETERS:</td>
<td>5</td>
</tr>
<tr>
<td>8.0</td>
<td>PRE-COMMISSIONING TESTS</td>
<td>8</td>
</tr>
</tbody>
</table>
CHAPTER 3 - SWITCHGEAR

SURGE ARRESTERS

1.0 GENERAL:

1.1 The Surge arresters shall conform to IEC: 60099-4 except to the extent modified in the specification and shall also be in accordance with requirements under Chapter 2-GTR.

1.2 Arresters shall be of hermetically sealed units, self supporting construction, suitable for mounting on tubular support structures to be supplied by the Contractor.

1.3 The Surge Arrestors shall be designed for use in the geographic and meteorological conditions as given in the Chapter 2-GTR.

2.0 DUTY REQUIREMENTS:

a. The surge arresters shall be of heavy duty station class and gapless type without any series or shunt gaps.

b. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

c. 245/145/36 kV class arrester shall be capable for discharging energy equivalent to class 3 of IEC for 245/145/36 kV system on two successive operations.

d. The surge arresters shall be suitable for withstanding forces as defined in Chapter 2-GTR.

e. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

f. The surge arresters are being provided to protect the following equipment whose insulation levels are indicated in the table given below:-

<table>
<thead>
<tr>
<th>Equipment to be protected</th>
<th>Lightning impulse (kVp) for 245 kV system</th>
<th>Lightning Surge for 145 kV system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power transformer</td>
<td>± 950</td>
<td>± 550</td>
</tr>
<tr>
<td>Instrument Transformer</td>
<td>± 1050</td>
<td>± 650</td>
</tr>
<tr>
<td>Reactor</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CB/Isolator Phase to ground</td>
<td>± 1050</td>
<td>± 650</td>
</tr>
</tbody>
</table>
### CONSTRUCTIONAL FEATURES:

The features and constructional details of surge arresters shall be in accordance with requirement stipulated hereunder:

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

**b)** The surge arresters shall be fitted with pressure relief devices suitable for preventing shattering of porcelain housing and providing path for flow of rated fault currents in the event of arrester failure. Details shall be furnished in the bids alongwith quality checks.

**c)** The arresters shall not fail due to arrester porcelain contamination.

**d)** Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

**e)** Outer insulator shall be porcelain/polymer conforming to requirements stipulated in Chapter 2-GTR. Terminal connectors shall conform to requirements stipulated under Chapter 2-GTR.

The outer insulator housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester.

**f)** The end fittings shall be made of corrosion proof material and preferably be nonmagnetic.

**g)** The name plate shall conform to the requirements of IEC incorporating the year of manufacture.

**h)** The heat treatment cycle details alongwith necessary quality checks used for individual blocks alongwith insulation layer formed across each block are to be furnished. Metalizing coating thickness for reduced resistance between adjacent discs is to be furnished with additional information schedule of bid proposal sheets alongwith procedure for checking the same. Details of thermal stability test for uniform distribution of current on individual disc is to be furnished.
i) The manufacturer will submit Data for rejection rate of ZnO blocks during manufacturing/operation for the past three years.

j) The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with the O-rings/elliptical cross-section gaskets of Neoprene or Butyl rubber.

k) The Surge arrester with porcelain housing shall have a cantilever strength of not less than 350 kg for 216/120kV surge arresters respectively or as per the value obtained vide Chapter 2-GTR, whichever is higher. For Surge arrester with polymer housing, the cantilever strength shall not be less than 150kg.

4.0 FITTINGS AND ACCESSORIES:

a) 216/120/30 kV Arresters shall be complete with insulating base and Surge monitor having provision for bolting to flat surface of structure.

b) Self contained discharge counters, suitably enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection. Suitable leakage current meters should also be provided. The reading of milliammeter and counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends.

c) Surge monitor consisting of discharge counters and milliammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP66 degree of protection. The standard supporting structure for surge arrester should be provided with a mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard mounting pad. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall have to be supplied by the Contractor.

The arrangement for Surge Monitor enclosure fixing to the structure shall be at its rear/bottom. Connection between the Surge Arrester base and Surge Monitor shall be through a 2.0 m (minimum) long insulated copper rod/strip of at least 75 sq.mm cross sectional area. The cable shall be terminated at rear/bottom side of the Surge Monitor. The gaskets of the surge monitors shall be of Neoprene, Butyl or equivalent material.

d) Grading/corona rings shall be provided on each complete arrester unit as required. Suitable terminal connectors shall be supplied by the Contractor.
5.0 TESTS:

5.1 In accordance with the requirements stipulated under Chapter 2-GTR, the surge arresters should have been type tested as per IEC and shall be subjected to routine and acceptance tests in accordance with IEC document. For contamination test, procedures outlined in 60099-3 shall be followed.

The test reports of the type tests and the following additional type tests (additional type tests are required for Surge Arresters above 72.5 kV class only) shall also be submitted for the Purchaser’s review.

i) Radio interference voltage test as per IEC 60099-4.

ii) Seismic withstand test.

iii) Contamination test.

iv) Test to verify the Power frequency versus time characteristics. Temporary over voltage profile for arresters are to be mutually agreed.

Each metal oxide block of surge arresters shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC: 60099-4.

5.2 (a) Acceptance Tests:

1. Measurement of power frequency reference voltage of the arrester units.

2. Lightning Impulse Residual voltage on arrester units. (IEC clause 6.3.2).

3. Internal Ionisation or partial Discharge test.

(b) Special Acceptance Test:

1. Thermal stability test on three sections. (IEC Clause 7.2.2).

2. Aging & Energy Capability test on blocks (procedure to be mutually agreed).

3. Wattloss test.

(c) Routine Tests:

1. Sealing test: Water dip test at 1.5m depth from top of Surge Arrester for 30 minutes shall be performed during assembly of Surge Arrester stacks (followed by other routine tests, i.e. P.D. Measurement, Reference Voltage, Residual Voltage & IR measurement).

3. Residual voltage test of arrester unit.
4. Internal ionisation test or partial discharge test.
5. Verticality check on completely assembled Surge arresters as a sample test on each lot.

(d) Test on Surge Monitors:

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10kA current impulse (8/20 micro sec.) shall also be performed on the Surge monitor.

Surge monitors shall be routinely tested for water dip test at 1.5m for 30 minutes. No water vapors shall be visible on the monitor glass.

(e) Test on Insulators

All routine tests shall be conducted on the hollow column insulators as per IEC 62155. Polymer housing shall be tested in accordance to IEC-61462.

6.0 SPARE PARTS AND MAINTENANCE EQUIPMENT:

Bidder shall include in his proposal spare parts and maintenance equipment, as mentioned in Chapter 1-PSR.

7.0 TECHNICAL PARAMETERS:

A. 245 kV CLASS SURGE ARRESTER

A7.0(a) Rated arrester voltage 216 kV
A7.0(b) Nominal discharge current 10 kA of 8/20 microsecond wave
A7.0(c) Minimum discharge capability 5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.
A7.0(d) Continuous operating voltage at 50 deg.C 168 kV rms
A7.0(e) Max. switching surge residual voltage (1kA) 500 kVp
A7.0(f) Max. residual voltage at
    i) 5 kA 560 kVp
ii) 10 kA nominal discharge current 600 kVp

A7.0(g) Max. steep current impulse residual voltage at 10 kA. 650 kVp

A7.0(h) Long duration discharge class 3

A7.0(i) High current short duration test value (4/10 micro second wave) 100 kAp

A7.0(j) Current for pressure relief test 40 kA rms / 50 kA rms (as applicable)

A7.0(k) Low current long duration test value (2400 micro sec) As per IEC.

A7.0(l) Pressure relief class 40 kA / 50 kA (as applicable)

B. 145 kV CLASS SURGE ARRESTER

B7.0(a) Rated arrester voltage 120 kV

B7.0(b) Nominal discharge current 10 kA of 8/20 microsecond wave

B7.0(c) Minimum discharge capability 5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics.

B7.0(d) Continuous operating voltage at 50 deg.C 102 kV rms

B7.0(e) Max. switching surge residual voltage (1kA) 280 kVp

B7.0(f) Max. residual voltage at
   i) 5 kA 310 kVp
   ii) 10 kA nominal discharge current 330 kVp

B7.0(g) Long duration discharge class 3

B7.0(h) High current short duration test value (4/10 micro second wave) 100 kAp
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7.0(i)</td>
<td>Current for pressure relief test</td>
<td>40 kA rms</td>
</tr>
<tr>
<td>B7.0(j)</td>
<td>Low current long duration test value (2400 micro sec)</td>
<td>As per IEC.</td>
</tr>
<tr>
<td>B7.0(k)</td>
<td>Pressure relief class</td>
<td>31.5 kA</td>
</tr>
</tbody>
</table>

### C 33kV Surge Arresters

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7.0(a)</td>
<td>Rated arrester voltage</td>
<td>30 kV</td>
</tr>
<tr>
<td>C7.0(b)</td>
<td>Nominal discharge capability</td>
<td>10 kA of 8/20 microsecond wave</td>
</tr>
<tr>
<td>C7.0(c)</td>
<td>Minimum discharge capability</td>
<td>5kJ/kV (referred to rated arrester voltage corresponding to minimum discharge characteristics)</td>
</tr>
<tr>
<td>C7.0(d)</td>
<td>Continuous operating voltage at 50 deg.C</td>
<td>24 kV rms</td>
</tr>
<tr>
<td>C7.0(e)</td>
<td>Max. switching surge residual voltage (0.5kA)</td>
<td>63 kVp</td>
</tr>
</tbody>
</table>
| C7.0(f) | Max. residual voltage  
  (i) 5 kA | 80 kVp |
| C7.0(g) | Long duration discharge class | 2 |
| C7.0(h) | High current short duration test value (4/10 micro second wave) | 100 kA |
| C7.0(i) | Current for Pressure Relief test | 40kA rms |
| C7.0(j) | Low current long duration test value (2000 micro sec) | As per IEC. |
| C7.0(k) | Pressure relief class as per IEC-60099-1 | A |
8.0 PRE-COMMISSIONING TESTS

8.1 An indicative list of tests is given below.

(a) operation check of LA counter.

(b) Insulation resistance measurement

(c) Capacitance and Tan delta measurement of individual stacks.

(d) Third harmonic resistive current measurement (to be conducted after energisation.)

Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.
# CHAPTER 4: LT SWITCHGEAR

## Table of contents

<table>
<thead>
<tr>
<th>Clause. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Constructional Details Of Switchboards And Distribution Boards</td>
<td>1</td>
</tr>
<tr>
<td>1.2</td>
<td>Derating Of Equipments</td>
<td>4</td>
</tr>
<tr>
<td>1.3</td>
<td>Power Bus Bars And Insulators</td>
<td>4</td>
</tr>
<tr>
<td>1.4</td>
<td>Earth Bus</td>
<td>4</td>
</tr>
<tr>
<td>1.5</td>
<td>Air Circuit Breakers</td>
<td>5</td>
</tr>
<tr>
<td>1.6</td>
<td>Moulded Case Circuit Breaker (Mccb) And Mcb</td>
<td>7</td>
</tr>
<tr>
<td>1.7</td>
<td>Relays</td>
<td>7</td>
</tr>
<tr>
<td>1.8</td>
<td>Contactors</td>
<td>8</td>
</tr>
<tr>
<td>1.9</td>
<td>Instrument Transformers</td>
<td>8</td>
</tr>
<tr>
<td>1.10</td>
<td>Indicating Instruments</td>
<td>9</td>
</tr>
<tr>
<td>1.11</td>
<td>Control &amp; Selector Switches</td>
<td>9</td>
</tr>
<tr>
<td>1.12</td>
<td>Air Break Switches</td>
<td>10</td>
</tr>
<tr>
<td>1.13</td>
<td>Push Buttons</td>
<td>10</td>
</tr>
<tr>
<td>1.14</td>
<td>Indicating Lamps</td>
<td>11</td>
</tr>
<tr>
<td>1.15</td>
<td>Fuses</td>
<td>11</td>
</tr>
<tr>
<td>1.16</td>
<td>Terminal Blocks</td>
<td>11</td>
</tr>
<tr>
<td>1.17</td>
<td>Name Plates And Labels</td>
<td>12</td>
</tr>
<tr>
<td>1.18</td>
<td>Space Heater</td>
<td>12</td>
</tr>
<tr>
<td>1.19</td>
<td>Control And Secondary Wiring</td>
<td>12</td>
</tr>
<tr>
<td>1.20</td>
<td>Power Cables Termination</td>
<td>13</td>
</tr>
<tr>
<td>1.21</td>
<td>Type Tests</td>
<td>13</td>
</tr>
<tr>
<td>1.22</td>
<td>Erection, Testing And Commissioning</td>
<td>14</td>
</tr>
<tr>
<td>1.23</td>
<td>Commissioning Check Tests</td>
<td>14</td>
</tr>
<tr>
<td>1.24</td>
<td>Special Tools And Tackles</td>
<td>16</td>
</tr>
<tr>
<td>1.25</td>
<td>Equipment To Be Furnished</td>
<td>17</td>
</tr>
<tr>
<td>1.26</td>
<td>Parameters</td>
<td>21</td>
</tr>
<tr>
<td>1.27</td>
<td>Automatic Control Of Outdoor Lighting</td>
<td>25</td>
</tr>
<tr>
<td>1.28</td>
<td>Automatic Supply Changeover</td>
<td>25</td>
</tr>
<tr>
<td>1.29</td>
<td>Analogue Inputs</td>
<td>26</td>
</tr>
<tr>
<td>1.30</td>
<td>Digital (Potential Free) Inputs</td>
<td>26</td>
</tr>
</tbody>
</table>
CHAPTER 4: LT SWITCHGEAR

1.1 CONSTRUCTIONAL DETAILS OF SWITCHBOARDS AND DISTRIBUTION BOARDS

1.1.1 All boards shall be of metal enclosed, indoor floor mounted, compartmentalised double front construction and freestanding type.

1.1.2 All board frames, shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Gland plate shall be cold rolled sheet steel having thickness not less than 3 mm in all cases. However, in case of termination of single core power cables, gland plate shall be of non-magnetic material of at least 4mm thickness.

1.1.3 All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

1.1.4 The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut-outs shall be true in shape and devoid of sharp edges.

1.1.5 All boards shall be of dust and vermin proof construction and shall be provided with a degree of protection of IP: 52, for category I enclosure as per IEC 60947 (Part-1). However, the busbar chambers having a degree of protection of IP: 42, in accordance with IEC 60947 (Part-1), are also acceptable where continuous busbar rating exceeds 1000 Amp. Provision shall be made in all draw out Air Circuit Breaker compartments for providing IP: 52 degree of protection, when Circuit breaker trolley, has been removed. Panels with lighting transformers shall have IP 31 degree of protection in accordance with IEC 60947 (Part-1). Door frame of panels, meters, relays, Breaker cut-outs shall be provided with neoprene rubber gaskets generally conforming to IEC/International Standards.

1.1.6 Provision of louvers on boards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating exceeds 1000 Amps. Panels with lighting transformers in lighting distribution boards shall have louvers.

1.1.7 All boards shall be of uniform height not exceeding 2450 mm.

1.1.8 Boards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers of bus bar chambers.

1.1.9 Boards shall be supplied with base frames made of structural steel sections, alongwith all necessary mounting hardware required for welding the base frames to the insert plates.

1.1.10 a) All boards shall be of double front construction and shall have 
   (i) A completely enclosed busbar compartment for running horizontal busbars and vertical busbars. Busbar chambers shall be completely enclosed with metallic portions. Bolted covers shall be provided for
access to horizontal and Vertical busbars for repair and maintenance, which shall be feasible without disturbing feeder compartment. Vertical bus bar chambers shall be accessible from front as well as back side of the panel and shall be of at least 350 mm width. One set of vertical busbars shall be used in between two adjacent sections for switchgear connections. In case of ACB feeders, the panel shall have single front without any vertical busbar chamber, however vertical busbars associated with ACBs shall be located in rear side and shall be additionally covered with metallic perforated/ transparent acrylic or polyvinyl bolted sheets to avoid direct access after opening rear door of chamber.

(ii) Completely enclosed switchgear compartment(s) one for each circuit for housing circuit breaker or MCCB or motor starter.

(iii) A distinct compartment or alley for power and control cables on each side of panel. Cable alley compartment shall have a through metallic partition for segregating cables on both sides. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts. Any live terminals shall be fully shrouded/insulated from safety aspects. However, it shall be of at least 350mm width.

(iv) A compartment for relays and other control devices associated with a circuit breaker.

b) Lighting transformers shall be supplied in separate and distinct panel completely assembled for incoming cable connection from bottom and outgoing connection through busbar with adjacent associated lighting distribution board. Lighting transformers shall have provision of base channel with rollers for taking in and out from the panel in case of maintenance after disconnecting incoming and outgoing connections. Provision of single phase fans at least two (2) numbers of suitable ratings shall be made in the panel for ventilation. These fans shall run in sequential mode at suitable time interval to be controlled by thermostat and timer. The offered design of panel should be such that in no case, temperature rise of lighting transformers shall exceed the permissible limits for the class of insulation of lighting transformer.

1.1.11 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.

1.1.12 All equipments associated with a single circuit except MCB circuits shall be housed in a separate compartment of the vertical section. The Compartment shall be sheet steel enclosed on all sides with the withdrawal units in position or removed. The front of the compartment shall be provided with the hinged single leaf door, with locking facilities. In case of circuits controlled by MCBs, group of MCB feeders can be offered in common compartment. In such case number of MCB feeder to be used in a common compartment shall not exceed 4 (four) and front of MCB compartment, shall have a viewing port of toughen glass sheet for viewing and sheet steel door of module shall be lockable with star knob/panel key.

1.1.13 After isolation of power and control circuit connections it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.
1.1.14 The minimum clearance in air between phases and between phase and earth for the entire run of horizontal and vertical busbars, shall be 25 mm. For all other components, the clearance between "two live parts", "A live part and an earthed part" and isolating distance shall be atleast ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal run of busbar minimum clearance of 25 mm should be maintained even if they are sleeved.

1.1.15 The temperature rise of horizontal & vertical busbars when carrying rated current along its full run shall in no case exceed 55°C, with silver plated joints and 40°C with all other type of joints over an outside ambient temperature of 50°C.

1.1.16 All busbar chambers shall be provided with removable bolted covers. The covers shall be provided with danger labels.

1.1.17 All identical circuit breakers and module chassis of same test size shall be fully interchangeable without having to carryout modifications.

1.1.18 All Circuit breaker boards shall be of Single Front type, with fully drawout circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between SERVICE, TEST and ISOLATED positions and for withdrawal from the Switchboard. Testing of the breaker shall be possible in the TEST position.

1.1.19 Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.

1.1.20 All disconnecting contacts for power circuits shall be of robust design and fully self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.

1.1.21 All AC & DC boards shall be of double Front type.

1.1.22 All module shall be fixed type except air circuit breaker module, which shall be drawer type.

1.1.23 The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be non-metallic and shall be of such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.

1.1.24 All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to PURCHASER approval. Bidder shall submit dimensional drawings showing complete internal details of Busbars and module components, for each type and rating for approval.

1.1.25 The tentative power and control cable entries shall be from bottom. However, Purchaser reserves the right to alter the cable entries, if required, during detailed engineering, without any additional commercial implication.
1.1.26 Adopter panels and dummy panels required to meet the various busbar arrangements and layouts required shall be included in Bidder’s scope of work.

1.2 DERATING OF EQUIPMENTS

1.2.1 The current ratings of all equipments as specified in the Single Line Diagram For AC & DC System are the minimum standards current ratings at a reference ambient temperature as per relevant Indian Standards.

1.3 POWER BUS BARS AND INSULATORS

1.3.1 All AC Distribution Boards shall be provided with three phase buses and a neutral bus bars and the DC Distribution Boards shall be provided with two busbars.

1.3.2 All busbars and jumper connections shall be of high conductivity aluminium/copper of adequate size.

1.3.3 The Cross-Section of the busbars shall be uniform throughout the length of Switchgear and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents.

1.3.4 All busbars shall be adequately supported by adequate numbers of high strength type Polyester fibre glass Moulded Insulators to withstand short circuit withstand capability of panel. Separate supports shall be provided for each phase and neutral busbar. If a common support is provided anti-tracking barriers shall be provided between the supports.

1.3.5 All busbars joints shall be provided with high tensile steel bolts. Belleville/spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated Busbars joints shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

1.3.6 All busbars shall be colour coded as per IEC: 60446.

1.3.7 The Bidder shall furnish calculations, establishing the adequacy of busbar sizes for specified current ratings, On the basis of short circuit current and temperature rise consideration at specified ambient temp.

1.4 EARTH BUS

1.4.1 A galvanised steel earthing shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded/bolted to the frame work of each panel and breaker earthing contact bar vertical bus shall be provided in each vertical section which shall in turn be bolted/welded to main horizontal ground bus.

1.4.2 The earth bus shall have sufficient cross-section to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise.

1.4.3 Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Purchaser’s earthing conductors. The horizontal earth bus
shall project out the switchboard ends and shall have predrilled holes for this connection. A joint spaced and taps to earth bus shall be made through at least two bolts.

1.4.4 All non-current metal work of the Switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosures frame work and the truck shall be maintained even after painting.

1.4.5 The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions. SERVICES & ISOLATED, as well as through out the intermediate travel.

1.4.6 Air Circuit Breaker (ACB) module frame shall get engaged to the vertical earth bus, before the disconnecting contacts on these module are engaged to the vertical busbar.

1.4.7 All metallic cases of relays, instruments and other panel mounted equipments shall be connected to earth by independent stranded copper wires of size not less than 2.5 mm$^2$. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering is not acceptable. Looping of earthing which would result in loss of earth connection to the devices when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths or earth bus is acceptable.

1.4.8 VT and CT secondary neutral point earthing shall be at one place only, on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

1.4.9 All hinged doors shall be earthed through flexible earthing braid.

1.4.10 Caution nameplate 'Caution-Live Terminals' shall be provided at all points where the terminals are like to remain live and isolation is possible only at remote end.

1.5 AIR CIRCUIT BREAKERS

1.5.1 Circuit breakers shall be three-pole air break horizontal drawout type and shall have inherent fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameter only after provision of releases or any other devices shall not be acceptable.

1.5.2 Circuit breakers shall be mounted along with it operating mechanism on a wheeled carriage. Suitable guides shall be provided to minimise misalignment of the breaker.

1.5.3 There shall be 'Service', 'Test' and 'Fully withdrawn positions for the breakers. In 'Test' position the circuit breaker shall be capable of being tested for operation without energising the power circuits i.e. the power Contacts shall be disconnected while the Control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the 'SERVICE', 'TEST' OR FULLY WITHDRAWN' position. It shall be possible to close the door in TEST position.
1.5.4 All circuit breakers shall be provided with 4 NO and 4 NC potentially free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker. Separate limit switches each having required number of contacts shall be provided in both ‘SERVICE’ & ‘TEST’ position of the breaker. All contacts shall be rated for making continuously carrying and breaking 10 Amps at 230V AC and 1 Amp (Inductive) at 220V DC.

1.5.5 Suitable mechanical indications shall be provided on all circuit breakers to show ‘OPEN’, ‘CLOSE’, ‘SERVICE’, ‘TEST’ and ‘SPRING CHARGED’ positions.

1.5.6 Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.

1.5.7 All circuit breakers shall be provided with the interlocks as explained in further clauses.

1.5.8 Movement of a circuit breaker between SERVICE AND TEST positions shall not be possible unless it is in OPEN position. Attempted drawl of a closed circuit breaker shall trip the circuit breaker.

1.5.9 Closing of a circuit breaker shall not be possible unless it is in SERVICE, TEST POSITION or in FULLY WITHDRAWN POSITION.

1.5.10 Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn. It shall however, be possible to open the shutters intentionally, against spring pressure for testing purpose.

1.5.11 A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

1.5.12 Circuit breakers shall be provided with electrical anti-pumping and trip free feature, even if mechanical antipumping feature is provided.

1.5.13 Mechanical tripping shall be possible by means of front mounted RED ‘Trip’ push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

1.5.14 Breaker controlled motors shall operate satisfactorily under the following conditions:

   (i) Direct on-line starting of Induction Motors rated 110 kW to 220 kW with a locked rotor current of seven times the rated current, and starting time of up to 30 seconds.

   (ii) Breaking on-load, full load and locked rotor currents of Induction Motors for rated 100 kW to 220 kW.

1.5.15 Means shall be provided to slowly close the circuit breaker in withdrawn position. If required for inspection and setting of Contacts, in service position slow closing shall not be possible.
1.5.16 Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC Control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class 'E' or better.

1.5.17 The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.

1.5.18 Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.

1.5.19 The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

1.5.20 Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.

1.5.21 All circuit breakers shall be provided with closing and trip coils. The closing coils shall operate correctly at all values of Voltage between 85% to 110% at rated control voltage. The trip coil shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.

1.5.22 Provision for mechanical closing of the breaker only in `TEST' and `WITHDRAWN' positions shall be made.

1.5.23 PROTECTION CO-ORDINATION

1.5.23.1 It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.

1.6 MOULDED CASE CIRCUIT BREAKER (MCCB) and MCB

1.6.1 MCCB shall in general conform to IEC: 60947 Part-2. All MCCB offered shall have Ics = 100% Icu rating.

1.6.2 MCCB shall be flush mounted on the AC/DC distribution boards and shall have extended handle.

1.6.3 MCCBs shall be provided with thermo-magnetic type release for over current and short circuit protection. The setting of the thermal release shall be adjustable between 80% to 100% of the rated current. The MCCB shall have breaking capacity not less than 20kA.

1.6.4 MCCBs used for ACDB incomers and Bus coupler shall be equipped with stored energy mechanism for electrical closing and tripping. All other MCCBs shall be manually operated. The operating handle should give a clear trip indication.

1.6.5 Miniature circuit breaker (MCB) shall conform to IEC: 60898.

1.7 RELAYS
1.7.1 All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-drawout cases.

1.7.2 All AC relays shall be suitable for operation, at 50 Hz with 110 volts VT secondary and 1 amp or 5 amp CT secondary.

1.7.3 All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

1.7.4 All protective relays auxiliary relays and timers shall be provided with hand reset operation indicators (Flags) for analysing the cause of operation.

1.7.5 All relays shall withstand a test voltage of 2 KV (rms) for one minute.

1.7.6 Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

1.7.7 All fuse-protected contactor-controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bimetallic strips), or as a separate device. The single phasing protection shall operate even with 80% of the set current flowing in two of the phases.

1.8 CONTACTORS

1.8.1 Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IEC: 60947 Part 4.

1.8.2 Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.

1.8.3 Direct on line starter contactors shall be of utilisation category AC2. These contactors shall be as per IEC:60947 Part 4.

1.8.4 Each contactor shall be provided with two (2) normally open (NO) and two (2) normally close (NC) auxiliary contacts.

1.8.5 Operating coils of contactors shall be of 230V AC Unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall drop out at 70% of the rated voltage.

1.9 INSTRUMENT TRANSFORMERS
1.9.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.

1.9.2 All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.

1.9.3 All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

1.9.4 Current transformers may be multi or single core type. All voltage transformers shall be single phase type. The Bus VTs shall be housed in a separate compartment.

1.9.5 All VTs shall have readily accessible MCBs on both primary and secondary sides.

1.10 INDICATING INSTRUMENTS

1.10.1 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

1.10.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

1.10.3 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

1.10.4 Ammeters provided on Motor feeders shall have a compressed scale at the upper current region to cover the starting current.

1.10.5 Watt-hour meters shall be of 3 phase three element type, Maximum demand indicators need not be provided.

1.11 CONTROL & SELECTOR SWITCHES

1.11.1 Control & Selector switches shall be of rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

1.11.2 Circuit breaker selector switches for breaker Controlled motor shall have three stay put positions marked `Switchgear', `Normal' and `Trial' respectively. They shall have two contacts of each of the three positions and shall have black shade handles.

1.11.3 Ammeter and voltmeter selector switches shall have four stayput position with adequate number of contacts for three phase 4 wire system. These shall
have oval handles Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries.

1.11.4 Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

1.11.5 The contact ratings shall be at least the following:

(i) Make and carry continuously 10 Amp.
(ii) Breaking current at 220V DC 1 Amp (Inductive)
(iii) Breaking current at 230V AC 5 Amp (at 0.3 pf lagging)

1.12 AIR BREAK SWITCHES

1.12.1 Air breaker switch shall be of the heavy duty, single throw group operated, load break, fault make type complying with IEC: 60947 Part-3.

1.12.2 The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.

1.12.3 Switch operating handles shall be provided with padlocking facilities to lock them in 'OFF' position.

1.12.4 Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in 'OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

1.12.5 Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

1.13 PUSH BUTTONS

1.13.1 Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 230V and 0.5A (inductive) at 220V DC.

1.13.2 All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

1.13.3 All push-buttons shall be provided with integral escutcheon plates marked with its function.

1.13.4 The colour of the button shall be as follows:

(i) GREEN : For motor START, Breaker CLOSE
(ii) RED : For motor TRIP, Breaker OPEN
(iii) BLACK : For overload reset.
1.13.5 All push-buttons on panels shall be located in such a way that Red-push-buttons shall always be to the left of green push-buttons.

1.14 INDICATING LAMPS

1.14.1 Indicating lamps shall be of the panel mounting cluster LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary.

1.14.2 Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

(i) RED : For motor ON, Breaker CLOSED
(ii) GREEN : For motor OFF, Breaker OPEN
(iii) WHITE : For motor Auto-Trip
(iv) BLUE : For all healthy conditions (e.g. control supply, and also for "SPRING CHARGED"
(v) AMBER : For all alarm conditions (e.g. overload) Also for 'SERVICE' and 'TEST' positions indicators.

1.14.3 Lamps shall be easily replaceable from the front of the cubicle.

1.14.4 Indication lamps should be located just above the associated push buttons/control switches. Red lamps invariable be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and Amber lamps should normally be located above the Red and Green lamps.

1.14.5 When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

1.15 FUSES

1.15.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC Circuits shall be of class 2 type, 20 kA (RMS) breaking current at 400 AC, and for DC circuits Class 1 type 4 kA breaking current.

1.15.2 Fuses shall have visible operation indicators.

1.15.3 Fuses shall be mounted on fuses carriers, which are mounted on fuse bases, wherever it is not possible to mount fuses on carriers fuses shall be directly mounted on plug in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

1.15.4 Fuse rating shall be chosen by the Bidder depending upon the circuit requirements and these shall be subject to approval of PURCHASER.

1.16 TERMINAL BLOCKS

1.16.1 Terminal blocks shall be of 750 volts grade and have continuous rating to carry the maximum expected current on the terminals. It shall be complete
with insulating barriers, clip-on-type/stud type terminals for Control Cables and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring on diagrams. It shall be similar to `ELEMEX' standard type terminals, cage clamp type of Phoenix or WAGO or equivalent.

1.16.2 Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities. It shall be similar to `Elem.' `CATD' - Type.

1.16.3 In all circuit breaker panels at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.

1.16.4 All terminal blocks shall be suitable for terminating on each side, two (2) Nos. of 2.5 mm square size standard copper conductors.

1.16.5 All terminals shall be numbered for identification and grouped according to the function. Engraved white-on-black labels shall be provided on the terminal blocks.

1.16.6 Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

1.16.7 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block. The minimum clearance between the first row of terminal block and the associated cable gland plate shall be 250 mm.

1.17 NAME PLATES AND LABELS

1.17.1 All switchgears, AC/DC distribution boards, shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

1.17.2 All name plates shall be of non-rusting metal or 3-ply lamicoid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to PURCHASER approval.

1.17.3 Suitable plastic sticker labels shall be provided for easy identification of all equipments, located inside the panel/module. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the module wiring drawings.

1.18 SPACE HEATER

1.18.1 Space heater shall be provided in all the boards for preventing harmful moisture condensation.

1.18.2 The space heaters shall be suitable for continuous operation on 230V AC, 50 Hz, single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.

1.19 CONTROL AND SECONDARY WIRING
1.19.1 All switchboards shall be supplied completely wired internally up to the terminal blocks ready to receive Purchaser's control cables.

1.19.2 All inter cubicle and inter panel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the bidder.

1.19.3 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour coded, PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires. Voltage grade and insulation shall be same as above.

1.19.4 Extra-flexible wires shall be used for wiring to device mounted on moving parts such as hinged doors.

1.19.5 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminals blocks.

1.20 POWER CABLES TERMINATION

1.20.1 Cable termination compartment and arrangement for power cables shall be suitable for stranded aluminium conductor, armoured XLPE/PVC insulated and sheathed, single core/three core, 1100 V grade cables.

1.20.2 All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. shall be provided by the successful bidder, to suit the final cable sizes which would be advised later.

1.20.3 The gland plate shall be of removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. For all single core cables, gland plates shall be of non-magnetic Material.

1.21 TYPE TESTS

1.21.1 Type tests reports on Panels (Switchgear and Control gear assemblies) as per IEC: 60439 Part-1 shall be submitted for the following tests in line with clause 9.0 of Chapter 2 GTR before the fabrication of switchgear is started:

   i) Verification of temperature rise limits
   ii) Verification of the dielectric properties
   iii) Verification of short circuit strength
   iv) Verification of the continuity of the protective circuit
   v) Verification of clearances and creepage distances
   vi) Verification of mechanical operation
   vii) Verification of degree of protection

1.21.2 Contractor shall submit type test reports for the following Switchgear and Control gears before the fabrication of switchgear is started:

   2. Protective Relays as per IEC: 60255.
   3. Lighting transformers as per IEC: 60076
For above equipments, test conducted once are acceptable (i.e. The requirement of test conducted within last five years shall not be applicable)

1.22 ERECTION, TESTING AND COMMISSIONING

1.22.1 The Contractor shall unload, erect, install, test and put into commercial use all electrical equipment included in this specification.

1.22.2 Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in Contractor's drawings or as stipulated by purchaser. No equipment shall be permanently bolted down to foundations until the alignment has been checked and found acceptable by the purchaser.

1.22.3 Contractor shall furnish all supervision, labour tools equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time required to completely install, test and commission the equipment.

1.22.4 Manufacturer's and purchaser's instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.

1.22.5 Contractor shall move all equipment into the respective room through the regular door or openings specifically provided for this purpose. No part of the structure shall be utilised to lift or erect any equipment without prior permission of Purchaser.

1.22.6 All boards shall be installed in accordance with relevant code of practices and at Purchaser's instructions. All boards shall be installed on finished surfaces, concrete or steel stills. Contractor shall be required to install and align any channel sills which form part of foundations. In joining shipping sections of switchboards together adjacent housing of panel sections or flanged throat sections shall be bolted together after alignment has been completed. Power bus, enclosures ground and control splices of conventional nature shall be cleaned and bolted together being drawn up with torque spanner of proper size or by other approved means.

1.22.7 All boards shall be made completely vermin proof.

1.22.8 Contractor shall take utmost care in holding instruments, relaying and other delicate mechanism wherever the instruments and relays are supplied separately they shall be mentioned only after the associated panels have been erected and aligned. The packing materials employed for safe transit of instrument and relays shall be removed after ensuring that panel have been completely installed and to further movement of the same should be necessary. Any damage shall be immediately reported to Purchaser.

1.22.9 Equipment furnished with finished coats of paint shall be touched by up Contractor if their surface is specified or marred while handling.

1.22.10 After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards/panels and correctness of all equipment in each and every respect. The cable opening and cables entries for cables terminating to the panels shall be sealed with fire sealing materials.

1.23 COMMISSIONING CHECK TESTS
The Contractor shall carry out the following commissioning checks, in addition to the other checks and tests recommended by the manufacturers.

1.23.1 **General**

1.23.1.1 Check name plate details according to the specification.

1.23.1.2 Check for physical damage.

1.23.1.3 Check tightness of all bolts, clamps, joints connecting terminals.

1.23.1.4 Check earth connection.

1.23.1.5 Check cleanliness of insulators and bushings.

1.23.1.6 Check all moving parts for proper lubrication.

1.23.1.7 Check settings of all the relays.

1.23.2 **Circuit Breakers**

1.23.2.1 Check alignment of breaker truck for free movement.

1.23.2.2 Check correct operation of shutters.

1.23.2.3 Check control wiring for correctness of connections, continuity and IR values.

1.23.2.4 Manual operation of breaker completely assembled.

1.23.2.5 Power closing/opening operation, manually and electrically.

1.23.2.6 Breaker closing and tripping time.

1.23.2.7 Trip free and anti-pumping operation.

1.23.2.8 IR values, minimum pick up voltage and resistance of coils.

1.23.2.9 Contact resistance

1.23.2.10 Simultaneous closing of all the three phases.

1.23.2.11 Check electrical & mechanical interlocks provided.

1.23.2.12 Check on spring charging motor, correct operation of limit switches, and time of charging.

1.23.2.13 All functional checks.

1.23.3 **Current Transformers**

1.23.3.1 Megger between winding and winding terminals to body.

1.23.3.2 Polarity test

1.23.3.3 Ratio identification checking of all ratios on all cores by primary injection of current.
1.23.3.4 Spare CT cores, if available, to be shorted and earthed.

1.23.4 **Voltage Transformer**
1.23.4.1 Insulation resistance test
1.23.4.2 Ratio test on all cores.
1.23.4.3 Polarity test.
1.23.4.4 Line connections as per connection diagram.

1.23.5 **Cubicle Wiring**
1.23.5.1 Check all switch developments.
1.23.5.2 Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawing. All interconnections between panels/equipment shall be similarly checked.
1.23.5.3 All the wires shall be meggered to earth.
1.23.5.4 Functional checking of all control circuit e.g. closing, tripping control, interlock, supervision and alarm circuit.

1.23.6 **Relays**
1.23.6.1 Check connections and wiring.
1.23.6.2 Megger all terminals to body.
1.23.6.3 Megger AC to DC terminals.
1.23.6.4 Check operating characteristics by secondary injection.
1.23.6.5 Check minimum pick up voltage of DC coils.
1.23.6.6 Check operation of electrical/mechanical targets.
1.23.6.7 Relays settings.
1.23.6.8 Check CT and VT connections with particular reference to their polarities for directional relays, wherever required.

1.23.7 **Meters**
1.23.7.1 Check calibration by comparing it with a sub-standard.
1.23.7.2 Megger all insulated portions.
1.23.7.3 Check CT and VT connections with particular reference to their polarities for power type meters.

1.24 **SPECIAL TOOLS AND TACKLES**
1.24.1 The Bidder shall include in his proposal any special tools and tackles required for erection, testing commissioning and maintenance of the equipments offered.

1.24.2 The list of these special tools and tackles shall be given in the bid proposal sheets alongwith their respective prices.

1.24.3 The total price of the special tools and tackles shall be included in proposal sheets.

1.25 EQUIPMENT TO BE FURNISHED

1.25.1 The Bidder shall quote for various AC/DC distribution boards in accordance with this specification.

1.25.2 Standard scheme of interconnection of switchboards and distribution boards alongwith tentative feeder disposition for each board is indicated in Standard SLD of AC & DC system enclosed alongwith bid documents. The bidder shall quote board prices on the basis of standard SLD and their estimation of feeders for entire present and future bays requirement. Any other feeder required as per system requirement for efficient and reliable operation shall be deemed to be included in bidder's scope.

1.25.3 The Bill of Materials for each type of module shall be as under. These are minimum indicative requirement of the system. The necessary auxiliary relays, push buttons and indicating lamps shall be provided as per scheme requirement. Any other item/component required within a module for efficient and reliable operation shall be deemed to be included in bidder's scope.

1.25.4 Module Type AE (Electrically controlled circuit breaker for incoming and Bus Coupler Circuit).

(i) One (1) Triple pole air circuit breaker complete with all accessories and power operated mechanism as specified.

(ii) Two (2) Neutral link.

(iii) Three (3) Current Transformer for metering.

(iv) One (1) Ammeter with selector switch.

(v) Three (3) Current Transformer for relaying.

(vi) One (1) Triple pole instantaneous over-current relay having the setting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time.

(vii) One (1) Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20 - 80% of CT secondary current and adjustable definite minimum time. The earth fault relay shall be provided with a stabilising resistor.

(viii) One(1) set Current and Voltage transducers.
(ix) One(1) set High speed tripping relays.

1.25.5 Module Type - M1 (Circuit Breaker Controlled Motor Feeder)

(i) One (1) Triple pole Air Circuit Breaker complete with accessories, and power operated mechanism as specified.

(ii) One (1) Three position 6 pole selector switch ‘SWITCHGEAR/NORMAL/TRIAL’.

(iii) Three (3) Current Transformer for metering.

(iv) One (1) Ammeter with Ammeter Selector Switch.

(v) Three (3) Current Transformer for relaying.

(vi) One (1) Triple pole instantaneous over-current relay for providing positive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as required.

(vii) One (1) Double pole inverse definite minimum time over current relays connected in R & B phases for over current protection of motor rated 110 kW - 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT Secondary current and time setting range of 0-30 Second. The relay shall be CDGM-22 of EE or equivalent.

(viii) One (1) Single pole adjustable definite time delay relay for motor overload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall have continuously adjustable time delay range of 2.5 to 25 Sec.

(ix) One (1) Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilising resistor.

(x) One(1) set Current and Voltage transducers.

(xi) One(1) set High speed tripping relay.

1.25.6 Module Type E

(i) One (1) Four pole MCCB

1.25.7 Module G-1 (VT Module with under Voltage Relay)

(i) Three (3) 400 / 110 volts single phase voltage transformer star/star
\[ \sqrt{3} \sqrt{3} \]
connect with star point solidly earthed mounted on common draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA Burden.

(ii) Six (6) HRC Fuses mounted on the above chassis.

(iii) One (1) Four position voltmeter selector switch.

(iv) One (1) Voltmeter (0-500V)

(v) One (1) Double pole instantaneous under voltage relays with continuous variable setting range of 40-80% of 110 Volts.

(vi) One (1) Time delay pick up relay having a time setting range of 0.5 to 3 secs. with 3 `NO'. Self reset contacts, suitable for 220V DC.

(vii) One (1) Auxiliary relay 220V DC with 2 NO. self reset contacts.

(viii) Three (3) Indicating lamps with series resistor and colour lenses (Red, Blue & Yellow).

1.25.8 Module Type G-2

(i) Three (3) HRC Fuse

(ii) One (1) Voltmeter (0-500V)

(iii) One (1) Voltmeter selector switch four position (R-Y, Y-B, B-R OFF).

(iv) Three (3) Indication lamps (Red, Blue & Yellow)

1.25.9 Module Type H & H (BC) (Isolating Switch Controlled Incoming Circuit)

(i) One (1) Four pole MCCB

(ii) One (1) Red Indicating lamp to indicate isolating switch closed position.

1.25.10 Module Type S : (DC Metering and Protection Module)

(i) One (1) Voltmeter 300-0-300V DC for 220V DC DB/Voltmeter 75V DC for 50V DC

(ii) One (1) Three (3) position voltmeter selector switch

(iii) One (1) Instantaneous under voltage relay with 95% of 220V DC. The resetting ratio of relay of relay should not be more than 1.25. The relay shall be provided with a series resistor and a push button across if for resetting (pick up) the relay at about 105% of the drop out voltage.
(iv) One (1) Instantaneous over voltage relay with setting range of 110% of 220V DC. The resetting ratio of relay should not be less than 0.8. The relay shall have a push button in series of resetting the relay at about 95% of the operating voltage.

(v) One (1) Earth leakage relay only for 220V DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220V DC/230V AC Auxiliary supply.

1.25.11

**Module Type X**

One (1) One (1) Double pole 250 V MCB/ MCCB suitable for 20kA for 1 sec. Fault level

1.25.12

**Module Type-DC (Incomer from Battery & Chargers)**

(i) One (1) Double pole 250V DC MCCB for incomer from Battery.

(ii) One (1) DC ammeter with shunt and range of 90-0-400 Amps. For 220V DC DB and 90-0-200 Amp for 50V DC DB.

(iii) Two (2) Double pole 250V DC MCCB/MCB

(iv) One (1) Double pole single throw 250V DC air break switch connecting battery & charger sections to DC DB.

(v) **One(1) set Voltage and Current Transducers**

1.25.13

**Module Type DG-1 (Electrically Controlled Circuit Breaker for Incomer from DG Set)**

a) One (1) Triple pole circuit breaker complete with all accessories and power operated mechanism as specified.

b) One (1) Frequency meter.

c) One (1) Voltmeter with selector switch.

d) One (1) Remote/Local Selector switch.

e) Three (3) Current transformer for metering.

f) Six (6) Current Transformers for differential protection (out of this 3 Nos. will be supplied loose for mounting in DG set panel).

g) Three (3) Current transformer for relaying.

h) One (1) Ammeter Selector Switch.

i) One (1) Ammeter

j) One (1) Wattmeter of range 0-300 KW.
k) One (1) Three pole voltage controlled definite time delay relay having current setting range of 50-200% of CT secondary current and adjustable time delay 0.3 to 3 secs.

l) One (1) Watt hour meter with six (6) digits and minimum count of one (1) kwh.

m) One (1) Single pole definite time over current relay having a continuous setting range of 50-200% of CT secondary current and a time delay of 2.5-25 secs connected in CT of Y phase for overload alarm. The relay shall have a setting ratio of not less than 90%.

n) One (1) Three pole differential protection relay having an operating current setting range of 10-40% of generator full load current. The relay shall be of high impedance type, with necessary stabilizing resistors.

o) Two (2) Push buttons for Remote starting & stopping of DG Set (Red, Green).

p) One (1) set Current and Voltage transducers.

q) One (1) set High speed tripping relays.

1.25.14 Module Type H1

One (1) Double pole DC Switch with pad locking facility in off position.

1.25.15 Module Type EL

(i) One (1) Four pole MCCB

(ii) One (1) Contactor

(iii) Electronic Timer suitable for continuous operation, push button and selector switch be as per scheme requirement

1.26 PARAMETERS

1.26.1 Power Supply

1.26.1.1 AC System 3 phase, 4 wire, solidly earthed

a) Voltage 400 Volts, ± 10%

b) Frequency 50 Hz ± 2.5%

c) Combined variation ± 105% Absolute Sum in Voltage & frequency
**DC System**

- **System Voltage**: 220V ± 10%
- **Fault Level**: 4 kA
- **System Voltage**: 48 V ± 10%
- **Fault Level**: --

**Control Supply Voltage**

- **Trip and closing coils**: 220V DC Unearthed
- **Spring charging**: 220V DC Unearthed

**Cubicle Data**

**Busbar Rating**

- **Continuous for Vertical panels**: As specified in Standard SLD For AC & DC system.
- **Short time (1 sec. kA (rms)**: 20 kA
- **Momentary (kA)**: 45 kA
- **Ambient Temperature**: 50°C
- **One Minute Power Frequency Withstand**
  - **Power Circuit**: 2500 Volts (rms)
  - **Control Circuit**: 2500 Volts (rms)

**Cubicle Colour Finish**

- **Interior**: Smoke Grey shade No.692
- **Exterior**: Smoke Grey shade No.692

**Circuit Breaker**

- **Type**: Air Break
- **No. of poles**: 3
- **Voltage & Frequency**: 400 Volts, ± 10%, 50 HZ + 2.5%
- **Rated Operating Duty**: As per IEC
- **Rated service short-circuit**: 20 kA (RMS)
Breaking capacity (Ics)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>f)</td>
<td>Short Circuit making current 45 kA (Peak)</td>
</tr>
<tr>
<td>g)</td>
<td>Short time withstand current for 1 sec. duration 20 kA (RMS) for 1 sec.</td>
</tr>
<tr>
<td>h)</td>
<td>Operating Mechanism current for 1 sec. duration 20 kA (RMS) for 1 sec.</td>
</tr>
<tr>
<td>i)</td>
<td>No. of auxiliary contacts 4 NO &amp; 4 NC contacts for Purchaser's use on fixed portion of the cubicle</td>
</tr>
<tr>
<td>j)</td>
<td>Short Circuit breaking current</td>
</tr>
<tr>
<td></td>
<td>I. AC Component 20 kA (RMS)</td>
</tr>
<tr>
<td></td>
<td>II. DC Component As per IEC: 60947 (Part 2)</td>
</tr>
</tbody>
</table>

### 1.26.5 MOULDED CASE CIRCUIT BREAKER

<table>
<thead>
<tr>
<th></th>
<th>AC System</th>
<th>DC System</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>No. of poles 4</td>
<td>2</td>
</tr>
<tr>
<td>b)</td>
<td>Voltage &amp; Frequency 400 Volts, ± 10%</td>
<td>250V 50 Hz ± 2.5%</td>
</tr>
<tr>
<td>c)</td>
<td>Rated Operating Duty As per IEC</td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Rated service short-circuit Breaking capacity (Ics) 20 kA (RMS)</td>
<td>4 kA</td>
</tr>
<tr>
<td>e)</td>
<td>Short Circuit making current 45 kA (Peak)</td>
<td>-</td>
</tr>
<tr>
<td>f)</td>
<td>No. of auxiliary Contacts (only for incomer And bus-coupler MCCBs) 1 NO &amp; 1 NC</td>
<td>1 NO &amp; 1 NC</td>
</tr>
<tr>
<td>g)</td>
<td>Rated Ultimate Short Circuit breaking capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I. AC Component 20 kA (RMS)</td>
<td>As per IEC</td>
</tr>
<tr>
<td></td>
<td>II. DC Component As per IEC 60947</td>
<td>As per IEC 60947</td>
</tr>
</tbody>
</table>

### 1.26.6 Meters

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Accuracy class 2.5</td>
</tr>
<tr>
<td>b)</td>
<td>One minute power frequency withstand test voltage in KV 2.0</td>
</tr>
</tbody>
</table>
1.26.7 Current Transformers

a) Type
   Cast resin, Bar primary

b) Voltage class and frequency
   650V, 50 Hz

c) Class of Insulation
   E or better

d) Accuracy class metering CT
   Class 1, VA adequate for application but not less than 7.5 VA.

e) Accuracy class protection CT
   5 P 15, VA adequate for application but not less than 7.5 VA.

f) Accuracy class differential protection
   PS, KPV = 300V

g) Short Time Current Rating (for CTs Associated with circuit breakers)
   I. Current
      20 kA (RMS)
   II. Duration
      One Second
   III. Dynamic Rating
      45 kA (Peak)
   IV. One minute power frequency withstand test voltage
      2.5 kV (rms)

1.26.8 Voltage Transformer

a) Type
   Cast Resin

b) Rated Voltage
   Primary
      400/\sqrt{3} V
   Secondary
      110/\sqrt{3} V

c) Method of connection
   Primary
      Star
   Secondary
      Star

d) Rated voltage factor
   1.1 continuous, 1.5 for 3 seconds

e) Class of insulation
   E or better

f) One minute power frequency withstand voltage
   2.5 KV (RMS)
1.26.9 **Relay**

a) One minute power Frequency withstand test

2 kV (rms)

1.26.10 **Transducers (1 phase)**

<table>
<thead>
<tr>
<th>Current</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>220 V DC</td>
<td>220V DC</td>
</tr>
<tr>
<td>1A.</td>
<td>110V AC</td>
</tr>
<tr>
<td>4-20 mA</td>
<td>4-20 mA</td>
</tr>
<tr>
<td>Analogue</td>
<td>Analogue</td>
</tr>
</tbody>
</table>

1.26.11 **Lighting Transformers**

Lighting transformers shall be of 100 KVA rating, 400/4400 V, 3 phase, 50 Hz Dry type natural air cooled type. The technical parameters of these lighting transformers are as follows:

**Technical Parameters of Lighting Transformer**

- **Type of transformer**: Dry type natural air cooled
- **Rating**: 100 KVA
- **Voltage ratio**: 400/400 volts
- **No. of phases**: Three
- **Frequency**: 50 Hz
- **Winding connection**: Dyn-1
- **Class of insulation**: ‘B’ class
- **Impedance**: 4% ± 10%
- **No. of taps & steps**: 5, ± 5% in steps of 2.5%
- **Ref. standard**: IEC: 60076

1.27 **AUTOMATIC CONTROL OF OUTDOOR LIGHTING**

1.27.1 EL-type module of 400V Main lighting distribution board and Emergency lighting distribution board and shall be controlled by timer and contactor module to facilitate its operation automatically.

1.28 **AUTOMATIC SUPPLY CHANGEOVER**

Automatic changeover between Incomer I, Incomer II, and DG set is to be carried out during the failure of supply in one/or both the incomers. After the restoration of the supply, system shall be restored to normal condition automatically. The requirement of changeover under various conditions are as below:

(i) Under normal conditions i.e. when supply is available in both the incomers, incomers
I&II of 400 V Main switchboard, ACDB shall be in closed condition and Bus couplers and DG set breaker shall be in open condition.

(ii) In case of failure of either of the sources, the incomer of that source shall trip and Bus coupler shall get closed. On restoration of supply, normal conditions described above are to be established automatically.

(iii) In case of failure of supply in both the sources, both incomers, incomers of ACDBs and ACDB Bus coupler shall trip and DG set breaker switched on. On restoration of one or both sources, DG set breaker shall trip, DG set stopped and conditions described in paragraph (i) / (ii) shall be restored.

To avoid unnecessary operation of switchgear for momentary disturbances all changeovers from one state to another shall be initiated after a time delay, after the conditions warranting such change has been detected.

1.29 ANALOGUE INPUTS

LT System shall have provision of following analogue inputs for owner’s substation automation purpose. These analogue inputs shall be generated by distinct transducers to be provided in respective modules. These inputs shall be wired up to respective terminal blocks.

**ANALOGUE INPUTS:**

i) Voltage R-Y, Y-B, B-R of Main Switch Board section-I
ii) Voltage R-Y, Y-B, B-R of Main Switch Board section-II
iii) Current from LT transformer-I
iv) Current from LT transformer-II
v) Voltage of 220V DCDB-I
vi) Voltage of 220V DCDB-II
vii) Current from 220V Battery set-I
viii) Current from 220V Battery set-II
ix) Voltage of 48V DCDB-I
x) Voltage of 48V DCDB-II
xi) Current from 48V Battery set-I
xii) Current from 48V Battery set-II

1.30 DIGITAL (Potential Free) INPUTS:

LT System shall have provision of following digital inputs for owner’s substation automation purpose. These digital inputs shall be made available in the form of potential free contacts to be provided in respective modules. These potential free contacts shall be wired up to respective terminal blocks.

**DIGITAL (Potential Free) INPUTS:**

i) Main (MSB) Incomer-I breaker On/Off
ii) Main (MSB) Incomer-II breaker On/Off
iii) Main(MSB) 400V Bus-I/II U/V
iv) Main (MSB) bus coupler breaker on/off
v) DG set breaker on/off
vi) LT transformer-I Bunchholz Alarm & trip
vii) LT transformer-II Buchloz Alarm & trip
viii) LT transformer-I WTI Alarm & trip
ix) LT transformer-II WTI Alarm & trip
x) LT transformer-I OTI Alarm & trip
xi) LT transformer-II OTI Alarm & trip
xii) 220 V DC-I earth fault
xiii) 220V DC-II earth fault
CHAPTER 5: BATTERY AND BATTERY CHARGER

Table of contents

<table>
<thead>
<tr>
<th>Clause.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.</td>
<td>General Technical Requirements</td>
<td>1</td>
</tr>
<tr>
<td>1.2.</td>
<td>Battery</td>
<td>1</td>
</tr>
<tr>
<td>1.3.</td>
<td>Battery Charger</td>
<td>5</td>
</tr>
</tbody>
</table>
CHAPTER: BATTERY & BATTERY CHARGER

1.1. GENERAL TECHNICAL REQUIREMENTS

1.1.1. All materials/components used in battery chargers and batteries shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.

1.1.2. DC System shall consist of two(2) float-cum-boost chargers and two(2) battery sets for each of 220V and 48 V systems respectively. The standard scheme drawing is enclosed with this specification.

1.1.3. Bidder shall select number of cells, float and Boost voltage to achieve following system requirement:

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>Maximum Voltage during Float operation</th>
<th>Minimum voltage available when no charger working and battery fully discharged upto 1.85V per cell.</th>
<th>Minimum Nos of cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>220 Volt</td>
<td>242 Volt</td>
<td>198 Volt</td>
<td>107</td>
</tr>
<tr>
<td>110 Volt</td>
<td>121 Volt</td>
<td>99 Volt</td>
<td>54</td>
</tr>
<tr>
<td>48 Volt</td>
<td>52.8 Volt</td>
<td>43.2 Volt</td>
<td>23</td>
</tr>
</tbody>
</table>

Bidder shall furnish calculation in support of battery sizing, selection of number of cells, float and Boost voltages during detailed engineering for Owners acceptance. Battery sizing calculations shall be done as per IEEE- 485 on the basis of following duty cycle:

<table>
<thead>
<tr>
<th>Load</th>
<th>Duration</th>
<th>Type Of Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>220V DC System</td>
<td>Continuous Load</td>
<td>3 hours Relays, IEDs, Station HMIs, spring charging, Isolator interlocking load, Miscellaneous permanently connected loads etc.</td>
</tr>
<tr>
<td>Emergency Load</td>
<td>1 hour</td>
<td>Substation emergency lighting loads.</td>
</tr>
<tr>
<td>Momentary Load</td>
<td>1 minute</td>
<td>Breaker closing, Tripping loads (taking simultaneous occurrence as per system)</td>
</tr>
<tr>
<td>48V DC System</td>
<td>Continuous Load</td>
<td>3 hours Continuous load associated with PLCs.(when speech is not working)</td>
</tr>
<tr>
<td>Momentary Load</td>
<td>15 minute</td>
<td>Loads associated with PLCs (when speech is working)</td>
</tr>
</tbody>
</table>

1.2. Battery

1.2.1. Type

The DC Batteries shall be VRLA (Valve Regulated Lead-Acid) type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. Air-conditioning shall be provided in Battery room the requirement of which has been specified elsewhere in the Technical Specification. The 220 V DC system is unearth and 48 V DC system is + ve earth system.

1.2.2. Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of
capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

1.2.3. **Containers**

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28 %. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

1.2.4. **Cell Covers**

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electrostatic spark are prevented.

1.2.5. **Separators**

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

1.2.6. **Pressure Regulation Valve**

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

1.2.7. **Terminal Posts**

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

1.2.8. **Connectors, Nuts & Bolts, Heat Shrinkable Sleeves**
Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge. Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.2.9. Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.2.10. Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.2.11. Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27° Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

The capacity (corrected at 27°Celsius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

(a) After Six minutes of discharge : 1.98V/cell
(b) After Six hours of discharge : 1.92V/cell
(c) After 8 hours of discharge : 1.85V/cell
(d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the
average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.2.12. **Expected Battery Life**

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

1.2.13. **Routine Maintenance of Battery system**

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

- Torque wrench.
- Cell test voltmeter(-3-0+3) volts with least count of 0.01Volt.

1.2.14. **Type Test of Battery**

1.2.14.1. Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. The type test reports shall be submitted in accordance with the requirements stipulated in clause no. 9.2 of Technical Specification, Chapter 2: GTR except that the requirement of tests having been conducted within last five years as mentioned therein shall not be applicable.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Gas emission</td>
</tr>
<tr>
<td>2.</td>
<td>High current tolerance</td>
</tr>
<tr>
<td>3.</td>
<td>Short circuit current and d.c. internal resistance</td>
</tr>
<tr>
<td>4.</td>
<td>Protection against internal ignition from external spark sources</td>
</tr>
<tr>
<td>5.</td>
<td>Protection against ground short propensity</td>
</tr>
<tr>
<td>6.</td>
<td>Content &amp; durability of required markings</td>
</tr>
<tr>
<td>7.</td>
<td>Material identification</td>
</tr>
<tr>
<td>8.</td>
<td>Valve operation</td>
</tr>
<tr>
<td>9.</td>
<td>Flammability rating of materials</td>
</tr>
<tr>
<td>10.</td>
<td>Intercell connector performance</td>
</tr>
<tr>
<td>11.</td>
<td>Discharge Capacity</td>
</tr>
<tr>
<td>12.</td>
<td>Charge retention during storage</td>
</tr>
<tr>
<td>13.</td>
<td>Float service with daily discharges for reliable mains power</td>
</tr>
<tr>
<td>14.</td>
<td>Recharge behaviour</td>
</tr>
<tr>
<td>15.</td>
<td>Service life at an operating temperature of 40ºC for brief duration exposure time.</td>
</tr>
<tr>
<td>16.</td>
<td>Impact of a stress temperature of 60ºC for brief duration exposure time with 3 h rate discharge test.</td>
</tr>
<tr>
<td>17.</td>
<td>Abusive over-discharge</td>
</tr>
</tbody>
</table>
Tests shall be conducted in accordance with IEC 60896-21 & IEC 60896-22, 2004

1.2.14.2. **List of Factory & Site Tests for Battery**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Test</th>
<th>Factory Tests</th>
<th>Site Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Physical Verification</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>2.</td>
<td>C/10 Capacity test on the cell</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>3.</td>
<td>8 Hrs. Charge and 15 minutes discharge test at full rated load</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

1.2.15. **Installation and commissioning**

1.2.15.1. Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor

1.2.16. Contractor shall be submitted following documents for approval:

   a) Data sheet as per Annexure-I  
   b) GA of cell and layout drawing  
   c) Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V.  
   d) Temperature correction factors  
   e) Installation and commissioning Instructions  
   f) O & M Manual

1.3. **Battery Charger**

The DC system for 220 V DC is unearthed and for 48 V DC is +ve earthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with offered VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead-Acid Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.28 to 2.32 volts per cell at the desired rate. Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer’s recommendation to avoid thermal runaway sensitivity, low temperature sensitivity, dimensional sensitivity at elevated internal pressure and temperature, and stability against mechanical abuse of units during installation.
runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

1.3.1. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within $\pm 1\%$ of the set value, for AC input voltage variation of $\pm 10\%$, frequency variation of $\pm 2.5\%$, a combined voltage and frequency variation of $\pm 10\%$, and a DC load variation from zero to full load.

1.3.2. All battery chargers shall have a constant voltage characteristics throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

1.3.3. All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

1.3.4. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.

1.3.5. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

1.3.6. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost Charging mode.

1.3.7. The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.

1.3.8. Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

1.3.9. **MCCB**

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB’s should have auxiliary contacts for annunciation.
1.3.10. Rectifier Transformer

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

1.3.11. Rectifier Assembly

The rectifier assembly shall be fully/half controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

1.3.12. Instruments

One AC voltmeter and one AC ammeter along with selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220 V chargers for testing purpose.

1.3.13. Air Break Switches

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. ‘ON’ and ‘OFF’ position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB’s of suitable ratings shall also acceptable in place of Air Break Switch.

1.3.14. Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

1.3.15. Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

1.3.16. Annunciation System

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:
   a) AC power failure
   b) Rectifier/chargers fuse blown.
   c) Over voltage across the battery when boost charging.
d) Abnormal voltage (High/Low)

e) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication “CHARGER TROUBLE” in Owner’s Control Board. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

1.3.17. Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments and ease of operation and maintenance.

1.3.18. Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger’s internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IEC:- 60947 Part 1.

1.3.18.1. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

1.3.18.2. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

1.3.18.3. The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

1.3.19. Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IEC/International Standards. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be in accordance with IEC/International Standards. Welding shall not be done after
phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

1.3.20. TESTS

1.3.20.1. Battery chargers shall conform to all type tests as per relevant International Standard. Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to all type tests specified in IEC: 60146 and short circuit test as per IEC:60076. Following type tests shall be carried out for compliance of specification requirements:
   i) Voltage regulation test
   ii) Load limiter characteristics test
   iii) Efficiency tests
   iv) High voltage tests
   v) Temperature rise test
   vi) Short circuit test at no load and full load at rated voltage for sustained short-circuit.
   vii) Degree of protection test
   viii) Measurement of ripple by oscilloscope.
   ix) Temperature compensation feature demonstration

1.3.20.2. The Contractor may be required to demonstrate to the OWNER that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before despatch as well as after installation at site. At site the following tests shall be carried out:
   i) Insulation resistance test
   ii) Checking of proper annunciation system operation.

1.3.20.3. If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the OWNER.

1.3.20.4. The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the OWNER.
   (i) Switches.
   (ii) Relays/ MCCBs
   (iii) Instruments.
   (iv) DC fuses.
   (v) SCR.
   (vi) Diodes.
   (vii) Condensers.
   (viii) Potentiometers.
   (ix) Semiconductor
   (x) Annunciator.
   (xi) Control wiring
   (xii) Push buttons and contactors.
Makes of above equipment shall be subject to Owner’s approval.

## Annexure-I

### BATTERY SYSTEM DATA SHEETS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description of Data</th>
<th>Unit</th>
<th>220 V / 110 V</th>
<th>48 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Battery Type:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grid alloy:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Pure lead(Pb),</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- lead calcium (Pb-Ca),</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- lead antimony (Pb-Sb),</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- or lead selenium (Pb-Se) or other pl. specify</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cell type:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Absorbed glass mat or gel cell or other please specify</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seller's type number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of positive plates per cell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Does each battery and battery [rack]/ [cabinet] meet the seismic requirements</td>
<td>[Yes]</td>
<td>[No]</td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Manufacturer's Designed Life of Battery</td>
<td>Yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Recommended Battery Charger Data:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Floating voltage range</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boost charge</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current rating</td>
<td>Amps.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recharge time</td>
<td>hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Heat Released During:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Discharge duty cycle</td>
<td>Watt</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Float charge</td>
<td>Watt</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Boost Charge</td>
<td>Watt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Maximum Amount of Hydrogen Gas Evolved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>During Battery-Boost Charge (2.33 V per cell) at Maximum Battery Temperature</td>
<td>(Litre /h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrogen Gas Evolution at Float</td>
<td>(Litre /h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g)</td>
<td>Time Battery may be Stored Without a Freshening Charge</td>
<td>months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h)</td>
<td>Temperature Compensation Provided and its Details</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

ICB/PMD/MCTLP/017/18-01          Procurement of plant
Page 10 of 12
2. Physical Description.

a) Battery Cell:

<table>
<thead>
<tr>
<th>Size (L x W x H)</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Kg</td>
</tr>
<tr>
<td>Volume of electrolyte</td>
<td>L</td>
</tr>
<tr>
<td>Jar cover material</td>
<td></td>
</tr>
<tr>
<td>Jar container material</td>
<td></td>
</tr>
<tr>
<td>Separator material</td>
<td></td>
</tr>
<tr>
<td>Retainer material</td>
<td></td>
</tr>
<tr>
<td>Limiting-oxygen index (LOI)</td>
<td></td>
</tr>
</tbody>
</table>

b) Battery [Rack] [Cabinet]:

<table>
<thead>
<tr>
<th>Outline or catalog number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of racks[cabinets] for the battery</td>
<td></td>
</tr>
<tr>
<td>Description (tier or step type)</td>
<td></td>
</tr>
</tbody>
</table>

c) Total Net Weight of Battery Including [Racks] [Cabinets] kg |

d) Total Shipping Weight of Each Battery Jar and Associated Equipment kg |

e) Connectors:

<table>
<thead>
<tr>
<th>Interconnection Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>No. per connection</td>
<td></td>
</tr>
</tbody>
</table>

Intercell [Tier] [Step]:

<table>
<thead>
<tr>
<th>Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td></td>
</tr>
<tr>
<td>No. per connection</td>
<td></td>
</tr>
</tbody>
</table>

Terminal Detail:

<table>
<thead>
<tr>
<th>Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td></td>
</tr>
</tbody>
</table>

f) Terminal Lugs for Power Cable:

g) Torque Data:

<table>
<thead>
<tr>
<th>Initial Torque Value</th>
<th>Retorque Value</th>
<th>Initial Torque Value</th>
<th>Retorque Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercell Connectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-[Tier] [Step]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Description of Data</th>
<th>Unit</th>
<th>220 V/ 110 V</th>
<th>48 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery String Designation No. [1] [ ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Float Voltage Without Boost</td>
<td>V/cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Float Voltage With Boost</td>
<td>V/cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boost Charge Voltage</td>
<td>V/cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended Frequency of Boost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Charge

<table>
<thead>
<tr>
<th>Recommended Duration of Boost Charge</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-Circuit Voltage V/cell</td>
<td></td>
</tr>
<tr>
<td>Short-Circuit Current at Battery Terminals at Float Voltage at (27°C):</td>
<td></td>
</tr>
<tr>
<td>Battery Discharge Characteristics A or A/positive plate</td>
<td></td>
</tr>
<tr>
<td>Guaranteed Amp-Hour Capacity (at the 10-hr rate) to Specified Final Voltage AH</td>
<td></td>
</tr>
<tr>
<td>One-minute A/cell</td>
<td></td>
</tr>
<tr>
<td>Fifteen-minute A/cell</td>
<td></td>
</tr>
<tr>
<td>One-hour A/cell</td>
<td></td>
</tr>
<tr>
<td>Two-hour A/cell</td>
<td></td>
</tr>
<tr>
<td>Three-hour A/cell</td>
<td></td>
</tr>
<tr>
<td>Eight-hour A/cell</td>
<td></td>
</tr>
<tr>
<td>Ten-hour A/cell</td>
<td></td>
</tr>
</tbody>
</table>

### 4. Required operating environment.

| Battery Room Ambient Temperature Range (°C to °C) |
|-----------------------------------------------|---|
| Battery Room Ambient Design Temperature °C |
| Battery Room Minimum/Maximum Design Temperature (°C to °C) |
| Maximum temperature at which battery can be stored °C |
CHAPTER 6: LIGHTING SYSTEM

Table of contents

<table>
<thead>
<tr>
<th>Clause.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Lighting System</td>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
<td>Lighting System For Substation</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Description Of Items</td>
<td>4</td>
</tr>
<tr>
<td>2.1</td>
<td>Description Of Items For Substation Lighting</td>
<td>4</td>
</tr>
<tr>
<td>2.2</td>
<td>Description Of Common Items For Lighting</td>
<td>8</td>
</tr>
</tbody>
</table>
1.0 LIGHTING SYSTEM

1.1 LIGHTING SYSTEM FOR SUBSTATION

The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry & accessories, lighting panels, lighting poles complete with distribution boxes, galvanized rigid steel /rigid PVC conduits, lighting wires, G.I. Earthwire, receptacles, tag block & telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories, for control room cum administrative building, switchyard panel room, Auxiliary building/Transit Camp, Fire Fighting pump house, Switchyard and street lighting.

The entire control room building, fire fighting pump house and Transit camp lighting shall be done by LED based low power consumption luminaries to achieve desired lux level specified. The bidder shall quote on lumpsum basis on the basis of design criteria specified for each control room building, Transit Camp and fire fighting pump house.

1.1.1 SYSTEM DESCRIPTION

The lighting system shall comprise of the following:

1.1.2 AC Normal Lighting

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

1.1.3 AC Emergency Lighting

This system will be available in control room building, Fire fighting pump house, & switchyard. AC lighting load will be connected to this system which will be normally 'ON'. The lighting panels of this system will be connected to the Emergency lighting board which is fed from diesel generator during the emergency. 25% of lighting fixtures shall be connected on AC emergency lighting.

1.1.4 D.C. Emergency lighting

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, Battery charger room, LT switchgear room in control room building, and Fire fighting pump house so that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON' automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and Bulkhead fixtures in non false ceiling area to be used.
1.1.5 Exit Lightings

All Exit lightings in the buildings shall be fed by DC lighting panels. All necessary wiring and its termination shall be in the contractor’s scope.

1.1.6 The lighting layout for and around Control Room Cum Administrative Office Building & Fire fighting Pump House indicating the type & BOQ for items shall be prepared and submitted by the contractor for owner’s approval during detailed engineering.

The lux levels to be maintained in the switchyard shall be as per following:

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Area</th>
<th>Area Average Lux at floor level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SN. Area Average Lux SN. Area Average Lux at floor level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SN. Area Average Lux Level SN. Area Average Lux at floor level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SN. Area Average Lux Level SN. Area Average Lux at floor level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SN. Area Average Lux Level SN. Area Average Lux at floor level</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Control Room Building, Firefighting pump house, Transit Camp</td>
<td>350 Lux</td>
</tr>
<tr>
<td></td>
<td>i) Control Room &amp; Conference - room</td>
<td>100 Lux</td>
</tr>
<tr>
<td></td>
<td>ii) Battery room, Passage, Pantry, Toilets, Corridors etc.</td>
<td>200 Lux</td>
</tr>
<tr>
<td></td>
<td>iii) All other rooms</td>
<td>50 lux on main Equipments (i.e., Transformer, Reactor ISO, CB, CT, CVT, SA) at first level (Equipment connections level.)</td>
</tr>
<tr>
<td>2.</td>
<td>Switchyard</td>
<td>20 lux on balance area of switchyard and street / Road at ground level.</td>
</tr>
<tr>
<td></td>
<td>-- 10 lux ( Area between fence and peripheral roads around the switchyard). The lighting between the fence and the peripheral road around switchyard shall be done by providing the lighting fixtures on lighting pole of suitable height, if required.</td>
<td></td>
</tr>
</tbody>
</table>

The minimum lux level to average lux level ratio should not be less than 0.6 (i.e Emin/Eav>0.6 ). The maintenance factor for indoor illumination design shall be considered as 0.8. The surface reflectance for ceiling/wall/floor shall be 50/30/10

For achieving the specified lux levels in the switchyard, the contractor can provide luminaries of 1x400 W/1x250 W and 2x400 W/ 2x250 W flood light as per requirement.

The contractor shall submit detailed calculation for reaching the above Lux level. Contractor shall conform the Lux levels at different locations of the switch yard and street lighting by measurement.

In addition to the normal lighting provided in the switchyard area to maintain the desired lux levels, high beam fixtures( Type SF4- 8 nos) on swivel support shall be provided in strategic locations near equipments for new substations which shall be kept normally OFF and these shall be switched
ON in case of maintenance work.

1.1.7 Ceiling fans (1400 mm sweep, AC 230 volts ) shall be provided in, fire
fighting pump house and non AC rooms in the control room building and all
the rooms in transit camp building & residential quarters as per the
requirements. Wall mounted fans shall be provided in the conference room,
control room, shift manager and substation incharge rooms in control room
building. Exhaust fans shall be provided in toilets and pantry.
The scope of work for Transit camp & township include of design,
engineering, testing, supply, installation, testing and commissioning of 415 V,
400Amp, Main Township Distribution board/Energy meter Boards/Flat DBs
etc (single line diagram C/ENGG/TS/STD/COMMON/01 enclosed for
reference purpose along with these calrifications), Power and Control cables,
various lighting fixtures complete with lamps, supports and accessories,
ceiling fans complete with electronic regulators, exhaust fans for toilets and
pantry & accessories, lighting panels, lighting poles complete with distribution
boxes, galvanized rigid steel/PVC conduits, lighting wires, G.I. Earthwire,
receptacles, tag block & telephone socket, bells, boxes for
telephone/television & Air-conditioners points, switchboards, switches,
junction boxes, pull out boxes complete with accessories as outlined in
electrical drawings enclosed with tender documents for various type of
quarters, parking, pump house, recreation centre and transit camp associated
with township.

1.1.8 One no. of aluminum ladder of each size shall be supplied by the contractor
for maintenance purpose.

1.1.9 The following specific areas are included in the scope of lighting:
(i) Switchyard Area.
(ii) Switchyard Control Room cum Administrative Office Building
(iii) Fire fighting pump house
(iv) Street lighting (peripheral) inside switchyard fencing (Street lighting
shall be done using street lighting poles)
v) DG area lighting
vi) LT Transformer area
vii) Transit Camp
viii) Residential quarters
ix) GIS building( including panel rooms)

1.1.10 For Outdoor Illumination

The switchyard and street lighting design including lux level calculations,
surface illuminance diagram at varying equipment surface levels , detailed
drawings showing the lighting layout and Electrical distribution diagram and
BOQ for items shall be prepared by the Contractor and submitted for
approval. The above layout drawings will include disposition and location of
lighting fixtures, receptacles, etc.
1.1.11 1.1.11 For Indoor Illumination

The conduit layout drawing for substation buildings, Electrical distribution diagram for substation buildings, & for substation yard etc. shall be prepared by the Contractor. All wiring including telephone wiring (tinned two pair copper) shall be in concealed conduit. Concealed MS junction boxes for sockets and light points shall be provided in all the rooms of Control Room cum Administrative Office Building and Fire Fighting pump house. In case where false ceiling surface conducting is permissible, all down run conduits will be concealed in wall below the false ceiling.

1.1.12 Each cable run shall be tagged with number that appear in the cable schedules. Cables shall be tagged at their entrance and/or exit from any piece of equipment, junction or pull box, floor opening etc.

1.1.13 The tag shall be made up of aluminum with the number punched on it and securely attached to the cable by not less than two turns of G.I. wire. Cable tags shall be rectangular in shape for power cables and circular shape for control cables.

1.1.14 Location of cables laid directly under ground shall be indicated clearly by cable marker made of galvanized iron plate embedded in concrete block.

1.1.15 The location of under ground cable joints if any, shall be clearly indicated with cable marker with an additional inscription "cable joint".

1.1.16 The marker, which is a concrete block, shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction. It shall also be located on both sides of the road or drain crossing.

2.0 DESCRIPTION OF ITEMS

2.1 DESCRIPTION OF ITEMS FOR SUBSTATION LIGHTING

The Contractor shall supply and install the following equipment and accessories in accordance with the specification.

2.1.1 LIGHTING PANELS

2.1.1.1 OUTDOOR

400 AC lighting panel with 400V, 63A, 3 phase 4 wire bus and one no. 63A, TPN, MCB with neutral unit as incomer and 20A, SP MCB as outgoing feeders, the details are as follows.

<table>
<thead>
<tr>
<th>Type Of Panel</th>
<th>Description</th>
<th>Detail Of Outgoing Feeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACP 2</td>
<td>Outdoor</td>
<td>6 nos- 20 A single pole MCB and 3 No. 32 A Triple pole MCB with Neutral and suitable timer and contactor for automatic switching.</td>
</tr>
</tbody>
</table>
ACP 3 | Outdoor Street lighting Panel | 3 nos.-32A Triple pole MCB with Neutral with suitable timer and contactor for automatic switching

Note: The number of outgoing feeders indicated above are the minimum.

2.1.1.2 INDOOR

400 V indoor AC lighting panel, 63 A 3 phase 4 wire bus and one number 63 amp FP MCB with 300ma 63 A FP RCCB. Flush mounted with per phase isolation and LED indication lamps. The DB will be flush mounted and double door type.

<table>
<thead>
<tr>
<th>Type Of Panel</th>
<th>Description</th>
<th>Detail Of Outgoing Feeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACP 1</td>
<td>Indoor</td>
<td>18 nos outgoing, 16 Amps SP MCB</td>
</tr>
</tbody>
</table>

220V DC indoor type change over board and 220V DC 32A two wire bus and one 32A contractor backed up by 32A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

<table>
<thead>
<tr>
<th>Type Of Panel</th>
<th>Description</th>
<th>Detail Of Outgoing Feeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCP</td>
<td>Indoor</td>
<td>6 nos outgoing, 16 Amps DP MCB</td>
</tr>
</tbody>
</table>

2.1.1.3 Sub-Lighting Panels

<table>
<thead>
<tr>
<th>Type Of Panel</th>
<th>Description</th>
<th>Detail Of Outgoing Feeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLP</td>
<td>Outdoor</td>
<td>4 pole 32A Isolator suitable for 400V, 50 cycles AC supply, with LILO facility using 8 nos terminal blocks suitable for cable upto 16 mm sq cable. Enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IEC:60529.</td>
</tr>
</tbody>
</table>

2.1.2 Lighting Fixtures

Please Refer Annexure-1

2.1.3 RECEPTACLES

<table>
<thead>
<tr>
<th>Description</th>
<th>Detail Of Outgoing Feeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO</td>
<td>15A, 230V, Receptacle 2 pole, 3-pin type</td>
</tr>
<tr>
<td>RP</td>
<td>63A, 400V, Interlocked switch socket, receptacle</td>
</tr>
<tr>
<td>RI</td>
<td>Indoor</td>
</tr>
</tbody>
</table>

2.1.4 (a) SWITCH BOARDS
Modular type switches, 5/15 Amp. Receptacles.

2.1.4 (b) CONDUITS AND ACCESSORIES
Galvanised Rigid steel or Rigid PVC conduits of 20/25/32 mm for Lighting and Telephone wiring

2.1.5 JUNCTION BOXES - with 5 Nos. of terminal blocks

2.1.6 LIGHTING POLES - (Type A1 poles & Type E1 poles)

2.1.7 FANS- 1400 mm Sweep with Electronic regulator and 450 mm Wall Mounted fans

2.1.8 MAINTENANCE EQUIPMENT
i) A type Aluminium ladder of 3 mtr vertical height.

ii) Cartwheel mounted aluminium ladder Vertical Extendable from 5.1m to 11m

2.1.9. RECEPTACLES
a) All receptacles shall be of cast steel/aluminium, heavy duty type, suitable for fixing on wall/column and complete with individual switch.

b) In general the receptacles to be installed are of the following types:

i) **Type RO**- 15A, 230V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2Cx6 sq.mm. PVC/aluminium armoured cable and a metallic cover tied to it with a metallic chain and suitable for installation in moist location and or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick GI sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gasketing. This shall conform to IP-55.

ii) **Type RI**- The 5/15 amp 6 pin receptacles with switches will be of Modular type with flush type switches and electroplated metal enclosures of approved make

iii) **Type RP** - 63A, 400V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3.5C x 35/3.5Cx70 sq.mm. aluminium conductor cable entry and shall also be suitable for loop-in and loop out connection of cables of identical size. Receptacle shall be suitable for outdoor
application. Receptacles shall be housed in a box made out of 2mm thick G.I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP-55.

2.1.10. **LIGHTING PANELS (L.P.)**

2.1.10.1 Each panel shall be provided with one incoming triple pole MCB with neutral link and outgoing miniature circuit breakers as per clause 2.0. The panels shall conform to IEC: 60439.

2.1.10.2 **Constructional Features**

a) Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be of thickness not less than 2.00 mm (cold rolled) smoothly finished, levelled and free from flaws. Stiffeners shall be provided wherever necessary. The indoor lighting panels will be ready made DB of minimum 1.6 mm sheet thickness.

b) The panels shall be of single front construction, front hinged and front connected, suitable for either floor mounting on channels, sills or on walls/columns by suitable M.S. brackets. Indoor panels in control room shall be flush mounted.

c) Panels shall have a dead front assembly provided with hinged door(s) and out door panels will be with padlocking arrangement with single key supplied in duplicate.

d) All out door panels, removable covers, doors and plates shall be gasket all around with neoprene gaskets.

e) The outdoor panels shall be suitable for cable/conduit entry from the top and bottom. Suitable removable cable gland-plate shall be provided on the top and bottom of panels. Necessary number of double compression cable gland shall be supplied, fitted on to this gland plate. The glands shall be screwed on top and made of tinned brass.

f) The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

g) Each panel shall have a caution notice fixed on it.

h) Each panel will be provided with directory holder in which printed and laminated as built circuit directory would be kept inside a document holder/pasted at site.

i) Each Outdoor lighting panel shall be provided with one no. ‘ON’ indicating lamp for each phase alongwith fuses. For indoor lighting panels din mounted phase indication lamps will be provided, mounted along side of the MCB.

j) **Main Bus Bars**

Bus bars shall be of aluminium alloy conforming to IEC: 60114/60105 and shall have adequate cross-section to carry the rated continuous and withstand short circuit currents. Maximum operating temperature of the bus
bars shall not exceed 85 deg. C. The bus bars shall be able to withstand a fault level of 9 kA for 1 sec. for AC panels and 4 KA for 1 sec. for DC panels. The Indoor lighting panels shall have copper bus bar

2.1.10.3 JUNCTION BOXES

a) The junction boxes shall be concealed type for indoor lighting and suitable for mounting on columns, lighting poles, structures etc., for outdoor lighting.

b) Junction boxes shall be of square/rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure diecast aluminium material LM-6 and shall have bolted cover with good quality gasket lining.

c) The junction box and cover of sheet steel construction shall be hot dip galvanised.

d) The junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips. The junction boxes shall be suitable for termination of Cable glands of dia 20 mm, 25 mm, 32 mm, 40 mm on all sides. The junction boxes shall be provided with 4 way terminals suitable for two numbers 10 sq. mm. wire & for street lighting/switchyard lighting suitable for 2 numbers 4C x 16 Sq.mm Al. cable.

e) The junction boxes shall have the following indelible markings

(i) Circuit Nos. on the top.
(ii) Circuit Nos. with ferrules (inside) as per drawings.
(iii) DANGER sign in case of 400 volt junction box.

f) The junction boxes shall be weather proof type with gaskets conforming to IP 55 as per IEC: 60529.

2.1.10.4 Occupancy Sensors:

Sufficient number of occupancy sensors shall be provided in the stairs area and corridors of control room cum administrative building. Each occupancy sensor shall be used for indoor use with time delay programmable in the minimum range of 1 sec. to 2 Hour to control the illumination in the area.

2.2 DESCRIPTION OF COMMON ITEMS FOR LIGHTING

2.2.1 LIGHTING FIXTURES AND ACCESSORIES

2.2.1.1 General

All lighting fixtures and accessories shall be designed for continuous operation under atmospheric conditions existing at site, without reduction in the life or without any deterioration of materials, internal wiring.

2.2.1.2 Temperature Rise

All lighting fixtures and accessories shall be designed to have a low temperature rise according to the relevant International standard. The design ambient temperature shall be taken as 50 deg.C.
2.2.1.3 **Supply Voltage**

Lighting fixtures and accessories meant for 230V A.C. operation shall be suitable for operation on 230V A.C. 50Hz, supply voltage variation of ± 10%, frequency variation of ± 2.5% and combined voltage and frequency variation of ± 10%.

Lighting fixture and accessories meant for 220V DC operation shall be suitable for operation on 220V DC with variation between 190 to 230 Volts.

2.2.1.4 **Lighting Fixtures**

a) The lighting fixtures shall be Philips or equivalent International make except for fixtures type ‘DSM’ & ‘HL’ for which make has been specified elsewhere in this chapter. The different types of lighting fixtures are also indicated elsewhere in this Chapter.

b) All fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

c) All lighting fixtures shall be complete with fluorescent tubes / incandesent lamps/mercury vapour/sodium vapour lamps as specified and shall be suitably wired up.

d) All fluorescent lamp fixture shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters, holders etc.

e) High beam fixtures shall be suitable for pendant mounting and flood lights shall have suitable base plate / frame for mounting on steel structural member. Hook mounted high beam fixtures are not acceptable.

f) Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

g) All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.

h) Height of fixtures should be such that it is easy to replace the lamps with normal ladder/stool. In case the ceiling height is very high, the fixtures may be placed on the walls for ground lighting.

2.2.1.5 **ACCESSORIES**

2.2.1.5.1 **Lamp holders and Starter Holders**

(a) Lamp holders/starter holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or retention of the lamp/starter. They shall hold the lamp/starter in position under normal condition of shock and vibration.

(b) Lamp holders/starter for incandescent lamps and HPMV/HPSV lamps shall be of screwed type, manufactured in accordance with relevant
standard and designed to give long and satisfactory service.

2.2.1.5.2 Ballasts

a) All HPSV/HPMV/Metal halide lamp fixtures shall be provided with wire wound ballasts. All fluorescent fixtures shall be provided with high frequency electronic ballasts. The Ballasts shall be designed, manufactured and supplied in accordance with relevant standard and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life and low power loss.

b) Ballasts shall be mounted using self locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

c) The wire-wound ballasts shall be of the inductive, heavy duty type, filled with thermosetting insulating moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Contractor. Ballasts for high pressure mercury vapour/ HPSV lamps shall be provided with suitable tappings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.

d) Separate ballast for each lamp shall be provided in case of multi-lamp fixtures.

e) High frequency electronic ballasts shall be capable of satisfactory performance in adverse environment like that of EHV substation. Ballasts shall consist of AC/DC converter, high frequency power oscillator and low pass filter. The ballasts shall be suitable for use of nominal voltage of 230V +/- 10%, 50 Hz supply. The filter circuit shall suppress the feedback of high frequency signals to the mains. The ballast shall be rated for 36/40W fluorescent fixtures. The ballasts shall confirm to IEC 68-2-6FC, IEC 60929 for performance, IEC 60928 for safety and EN 55015, EN 55022A for RFI and EN 61003.

2.2.1.5.3 Capacitors

a) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

b) Power factor of fluorescent lamp fixtures with HF electronic ballast shall not be less than 0.90 and that of High pressure Sodium Vapour, Mercury Vapour and Metal Halide lamp fixtures shall not be less than 0.85. The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.98 lag.

c) The capacitors shall be hermetically sealed in a metal enclosure.

2.2.1.5.4 Lamps

a) General Lighting Services (GLS) lamps shall be provided with screwed caps
b) The Bidder shall furnish typical wiring diagram for Fluorescent, HPMV & HPSV fitting including all accessories. The diagram shall include technical details of accessories i.e. starters, chokes, capacitors etc.

c) Flexible conduits if required, for any fixture shall be deemed to be included in Contractor’s scope.

2.2.1.5.5 SWITCH AND SWITCHBOARD

(a) All Switch board/boxes, 5/15 Amp Receptacles and electronic fan regulators located in office/building areas shall be modular flush mounted type or brick wall with only the switch knob projecting outside.

(b) Switch boards/boxes shall have conduit knock outs on all the sides.

(c) The exact number of switches including regulator for fans and layout of the same in the switchboard shall be to suit the requirement during installation.

(d) The maximum number of luminaires, controlled by one no 6 amp switch would 4 nos. For DC fixtures there will be no switch and the same shall be directly controlled from DC LP.

(e) The luminaires shall be wired in such a fashion that luminaires on each phase are evenly distributed all over the room.

2.2.1.5.6 CONDUITS & CONDUIT ACCESSORIES

a) The conduits shall conform to IEC: 61386 or IEC: 61035 or IEC: 60614 as applicable. All steel conduits shall be seemed by welding, shall be of heavy gauge and shall be hot dip galvanised.

b) Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips or PVC/Plastic.

c) All conduits accessories shall conform to relevant IEC and shall be hot dip galvanised or High quality virgin PVC.

2.2.1.5.7 TERMINAL BLOCKS

Each terminal shall be suitable for terminating upto 2 Nos. 10 sq.mm stranded Aluminium Conductors without any damage to the conductors or any looseness of connections. Terminal strips provided in street - lighting poles shall be suitable for terminating upto 2 nos. 4C x 16 sq. mm aluminium cables.

2.2.1.5.8 PULL OUT BOXES

a) The pull out boxes shall be concealed type for indoor lighting and suitable for mounting on column, structures etc., for outdoor lighting. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.
b) The pull out boxes shall be circular of cast iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.

c) The pull out boxes and cover shall be hot dip galvanised.

d) The pull out boxes shall be completed with conduit knock outs/threaded hubs and provided at approximately 3 meters intervals in a conduit run.

2.2.1.5.9 **Residual Current Circuit Breakers (RCCB)**

For indoor panels 63A 4pole 300 ma RCCB conforming IEC 13947 will be provided along with incomer.

2.2.1.5.10 **Miniature Circuit Breaker (MCB)**

a) The miniature circuit breakers shall be suitable for manual closing, opening, automatic tripping under overload and short circuit. The MCBs shall also be trip free. MCB of Type C tripping characteristics as per IEC: 60898 will be used for Switchyard lighting.

b) Single pole as well as three pole versions shall be furnished as required in the Schedule of Lighting Panels.

c) The MCBs and panel MCCB together shall be rated for full fault level. In case the MCB rating is less than the specified fault level the bidder shall co-ordinate these breaker characteristics with the back up MCCB in such a way that if fault current is higher than breaker rating, the MCCB should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer MCCB.

d) The MCBs shall be suitable for housing in the lighting panels and shall be suitable for connection with stranded copper wire connection at both the incoming and outgoing side by copper lugs or for bus bar connection on the incoming side.

e) The terminals of the MCBs and the ‘open’ ‘close’ and ‘trip’ conditions shall be clearly and indelibly marked.

f) The tenderer shall check and co-ordinate the ratings of MCBs with respect to starting characteristics of discharge lamps. The vendor has to furnish overload and short circuit curve of MCB as well as starting characteristics curves of lamps for Employer’s approval.

g) The MCB shall generally conform to IEC: 60898.

2.2.1.5.11 **Contactors**

Contactors shall be of the full voltage, direct-on line air break, single throw, electro-magnetic type. They shall be provided with atleast 2-‘NC’ and 2’NO’ auxiliary contacts. Contactor shall be provided with the three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated current. Hand reset button shall be flush with the front of the cabinet and suitable for resetting with starter compartment door closed. The Contactor shall be
suitable for switching on Tungsten filament lamp also. The bidder shall check the adequacy of the Contactors rating wire with respect to lighting load.

2.2.1.5.12 **Push Buttons**

All push buttons shall be of push to actuate type having 2 ‘NO’ and 2 ‘NC’ self reset contacts. They shall be provided with integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

2.2.1.5.13 **Labels**

   a) The lighting panels shall be provided on the front with panel designation labels on a 3 mm thick plastic plate of approved type. The letter shall be black engraved on white back ground.

   b) All incoming and outgoing circuits shall be provided with labels. Labels shall be made of non-rusting metal or 3 ply lamicold. Labels shall have white letters on black or dark blue background.

2.2.1.5.14 **Earthing Terminals**

Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 G.S. Flat.

2.2.1.5.15 **Type test reports for following tests on all lighting panels shall be submitted for approval as per clause 9.2 of Chapter 2: GTR.**

   (i) Wiring continuity test
   (ii) High voltage (2.5 KV for 1 minute) and insulation test
   (iii) Operational test
   (iv) Degree of protection (not less than IP-55 test on outdoor Lighting Panels and IP-52 test on indoor Lighting Panels as per IEC: 60947 (part 1)
   (v) Heat run test

2.2.1.5.16. **LIGHTING POLES**

   a) The Contractor shall supply, store and install the following types of steel tubular lighting poles required for street lighting.

      i) Type A1 Street Lighting Pole - for one fixture

      ii) Type E1 Post top lantern pole - for one fixture

   b) Street/flood light poles shall conform to the enclosed drawings. In front of control room building, and Fire Fighting Buildings, decorative post top lantern (Type E1) poles and Bollards shall be installed.

   c) Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted one meter above ground level.

   d) The lighting poles shall be coated with bituminous preservating paint on the inside as well as on the embedded outside surface. Exposed outside surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium).
e) The galvanised sheet steel junction box for the street lighting poles shall be completely weather proof conforming to IP-55 and provided with a lockable door and HRC fuse mounted on a fuse carrier and fuse base assembly. The fuses & junction box shall be as specified in the specification. However, terminals shall be stud type and suitable for 2 nos. 16 sq.mm. cable.

f) Wiring from junction box at the bottom of the pole to the fixture at the top of the pole shall be done through 2.5 sq. mm wire.

g) Distance of centre of pole from street edge should be approximately 1000 to 1200 mm.

h) Earthing of the poles should be connected to the switchyard main earth mat wherever it is available and the same should be earthed through 3M long, 20 mm dia, earth electrode.

2.2.1.5.17 CEILING & WALL MOUNTED FANS AND REGULATORS

a) The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories. The wall mounted fans shall be of 400 mm sweep.

b) The contractor shall supply and install the switch, electronic regulator and board for mounting switch and electronic regulator for ceiling fans. The regulator will be housed in common switchboard for lighting and shall be of similar make and model as that of modular switches.

c) Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.

d) Electronic regulator with stepped control shall be provided.

2.2.1.5.18 LIGHTING WIRES

a) The wiring used for lighting shall be standard products of reputed manufacturers.

b) The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.

c) The conductor sizes for wires used for point wiring beyond lighting panels shall be 2.5 sq.mm, 4 sq.mm, 6 sq.mm and 1.5 sq.mm stranded copper wire.

d) The wires used for connection of a lighting fixture from a nearest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IEC:60502 with nominal conductor cross sectional areas of 2.5 sq. mm.

e) The wires shall be colour coded as follows:

   Red for R - Phase
   Yellow for Y - Phase
   Blue for B - Phase
Black for Neutral
White for DC (Positive)
Grey for DC (Negative)

2.2.1.5.19 LIGHTING SYSTEM INSTALLATION WORKS

2.2.1.5.19.1 General

In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Employer, Contractor shall unload, erect, install, test and put into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanship manner so that it is level, plumb square and properly aligned and oriented. Tolerances shall be as established in manufacturers drawing or as stipulated by Purchaser.

All apparatus, connections and cabling shall be designed so as to minimize risk of fire or any damage which will be caused in the event of fire.

2.3.1.5.19.2 Conduit System

a) Contractor shall supply, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes (as specified in specification ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanized steel), caps, square headed make plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, glands, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits. The contractor shall also supply 20 mm PVC conduit and accessories for telephone wiring.

b) All unarmoured cables/wires shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

c) Size of conduit shall be suitably selected by the Contractor.

d) Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

e) Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

f) Where conduits are along with cable trays they shall be clamped to supporting steel at an interval of 600 mm.

g) For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

h) For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.
i) Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

j) Conduits joints and connections shall be made through water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

k) The entire metallic/PVC conduit system, shall be embedded, electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

l) Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.

2.2.1.5.19.3 Wiring

a) Wiring shall be generally carried out by PVC insulated wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.

b) Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Where required, suitable junction boxes shall be used.

c) Wiring shall be spliced only at junction boxes with approved type terminal strip.

d) For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

e) For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.

f) Maximum two wires can be terminated to each way of terminal connections.

g) Separate neutral wires are to be provided for each circuit.

h) AC and DC wiring should not run through the same conduit.

2.2.1.5.19.4 Lighting Panels

a) The lighting panels shall be erected at the locations to be finalised during detailed engineering.

b) Suitable foundations/supporting structures for all outdoor type lighting panels shall be provided by the Contractor.

2.2.1.5.19.5 Foundation & civil works
a) Foundation for street lighting poles, panel foundation and transformer foundation shall be done by the Contractor. The payment towards execution, PCC & RCC shall be made under relevant items of civil work mentioned in Bid Price schedule.

b) All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sill, inserts and fastening devices shall be carried out by the Contractor including minor modification of civil works as may be required for erection.

c) Any cutting of masonry / concrete work, which is necessary shall be done by the Contractor at his own cost and shall be made good to match the original work.

ANNEXURE-1

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of Lighting Fixture</th>
<th>Description</th>
<th>Philips Catalogue No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F1</td>
<td>2x28W T5 type fluorescent lamps in industrial reflector type fixture, complete with accessories and suitable for pendent /surface mounting.</td>
<td>TMS122/228 HF</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>2x28 T5 energy efficient fluorescent lamps with low glare, mirror optics suitable for recess mounting type lighting fixture.</td>
<td>TBS088/228 C5 HF</td>
</tr>
<tr>
<td>3</td>
<td>FL</td>
<td>2x28W T5 energy efficient fluorescent lamps with low glare mirror optics suitable for pendent/surface mounting with all accessories</td>
<td>TCS398/228 D6 HF</td>
</tr>
<tr>
<td>4</td>
<td>TL</td>
<td>Sleek and Functional electronic deco-batten suitable for use with 1x’TLD’36W fluorescent lamp with dual tone end caps. Pre-phosphated &amp; powder coated CRCA steel channel complete with all electrical accessories like electronic ballast, lamp holders all prewired up to a terminal block</td>
<td>TMS500/136 HF</td>
</tr>
<tr>
<td>5</td>
<td>IB</td>
<td>60/100w GLS lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall, and ceiling mounting finished stove enameled silver grey outside</td>
<td>NXC101</td>
</tr>
<tr>
<td>No.</td>
<td>Code</td>
<td>Description</td>
<td>Model Number</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>6</td>
<td>BL</td>
<td>Aesthetic wall/ceiling mounted luminaire suitable for 1x PL-C 13W OR 11W CFL. Low loss O.C. Copper ballast. Built in high gloss anodized reflector. Twin finish UV stabilised SAN diffuser for protection &amp; elimination of lamp glare.</td>
<td>FMC21/113</td>
</tr>
<tr>
<td>7</td>
<td>SL</td>
<td>Aesthetic ceiling mounted luminaire for Ecotone crystal/Décor CFL of 2x9W or 1x18W. ABS housing pre-wired with porcelain lampholder. Pre-phospated plated CRCA gear tray.</td>
<td>FL343/118</td>
</tr>
<tr>
<td>8</td>
<td>BH</td>
<td>Bulkhead luminaire suitable for use with PL-S 9W CFL. Single piece pressure die-cast aluminium &amp; cover retaining Frame. Opal acrylic cover along with a gasket made of E.P.R..</td>
<td>FXC 101/109</td>
</tr>
<tr>
<td>9</td>
<td>BLD</td>
<td>2x9 Or 1x18 watt CFL bollard light for landscape lighting having FRP/LLDPE housing</td>
<td>FGC202/118</td>
</tr>
<tr>
<td>10</td>
<td>DLR</td>
<td>2x18 watt CFL Downlighter with HF ballast suitable for recess mounting</td>
<td>FBH145/218L HF</td>
</tr>
<tr>
<td>11</td>
<td>DSM</td>
<td>1X13 WATT surface mounted CFL</td>
<td>FCS100/113</td>
</tr>
<tr>
<td>12</td>
<td>IF</td>
<td>Incandescent GLS lamp down light</td>
<td>DN622</td>
</tr>
<tr>
<td>13</td>
<td>SF1</td>
<td>1 X 400W HPSV lamps in high flood lighting fixture with integral control gear</td>
<td>SWF 330/1X400</td>
</tr>
<tr>
<td>14</td>
<td>SF2</td>
<td>2 X 400W HP sodium Vapour lamps in high flood lighting, non-integral control gear</td>
<td>RVP302/2x400W</td>
</tr>
<tr>
<td>15</td>
<td>SF3</td>
<td>1 X 250W HPSV lamps in high flood lighting fixture with integral control gear</td>
<td>SWF 330/1X250</td>
</tr>
<tr>
<td>16</td>
<td>SF4</td>
<td>150W HP Metal halide MHN-TD lamp in flood lighting fixture with integral control gear.</td>
<td>SWF230/150 MHN-TD</td>
</tr>
<tr>
<td>No.</td>
<td>Code</td>
<td>Description</td>
<td>Model</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>17</td>
<td>SF5</td>
<td>125 HP MV Lamp in weatherproof post top lantern for mounting on pole top</td>
<td>HPC-101/125 HPF</td>
</tr>
<tr>
<td>18</td>
<td>SC</td>
<td>150W SON-T Tubular Sodium Vapour lamp in street lighting</td>
<td>SRX-51/150</td>
</tr>
</tbody>
</table>
# CHAPTER-7: LT TRANSFORMER

## Table of contents

<table>
<thead>
<tr>
<th>Clause.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTENT</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>SCOPE OF WORK</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>General Information</td>
<td>1</td>
</tr>
<tr>
<td>4.0</td>
<td>TECHNICAL REQUIREMENTS</td>
<td>2</td>
</tr>
<tr>
<td>5.0</td>
<td>Inspection and Testing</td>
<td>3</td>
</tr>
<tr>
<td>6.0</td>
<td>Inspection</td>
<td>3</td>
</tr>
<tr>
<td>7.0</td>
<td>Factory Test</td>
<td>4</td>
</tr>
<tr>
<td>8.0</td>
<td>Fittings</td>
<td>6</td>
</tr>
<tr>
<td>9.0</td>
<td>Spare Parts</td>
<td>6</td>
</tr>
<tr>
<td>10.0</td>
<td>Technical Specification</td>
<td>7</td>
</tr>
</tbody>
</table>
CHAPTER 7: LT TRANSFORMER

1.0 INTENT

This specification is intended to cover outdoor type oil filled 33/0.400KV, 630 kVA & 11/0.400kV, 630kVA transformers.

2.0 SCOPE OF WORK

2.1 Scope of Supply

- Transformers as listed above, with insulating oil, all materials and accessories, and complete in all respects.

- Gland plates, power cable, lugs, anchor bolts and hardwares.

- Mandatory & optional spares and special maintenance equipments if any.

2.2 Scope of Service

The scope includes but is not limited to the following items of work to be performed for all equipment and materials furnished under this chapter:

a) Design, manufacturing, shop testing, packing & despatch
b) Transportation inclusive of insurance and delivery, FOR site basis
c) Unloading, handling, storing, transportation at site up to foundations, oil filling and treatment, erection, testing and commissioning
d) Civil Works
e) Supply of external cables and termination as required.
f) Fire protection system.

3.0 General Information

3.1 All temperature indicators, Buchholz relays and other auxiliary devices shall be suitable for 220 V DC Control supply. All alarm and trip Contacts shall also be suitable for connection in 220V DC Circuits.

3.2 Bidders may specifically note that transformers offered shall conform to dynamic short circuit test and dielectric test as per IEC: 60076. Test report for the same shall be submitted during detail engineering for approval.
4.0 TECHNICAL REQUIREMENTS

4.1 Core

The core shall be constructed from high grade, non-aging, cold rolled grain-oriented silicon steel laminations. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density at any tap position with 10% voltage variation from the voltage corresponding to the tap shall not exceed 1.9 Wb/sq-m.

4.2 Windings

The conductor shall be of electrolytic copper, free from scales and burrs.

4.3 Insulating Oil

The oil supplied with transformer shall be unused and have the parameters for unused new oil conforming to IEC: 60296 while tested at oil Contractor's premises, No inhibitors shall be used in oil. Ten percent extra oil shall be supplied for topping up after commissioning in nonreturnable containers suitable for outdoor storage.

4.4 Terminal Arrangement

a) Bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable/overhead conductors termination of HV side and cable termination on LV side.

b) The neutral terminals of 400V winding shall be brought out on a bushing along with the 433 volt phase terminals to form a 4 wire system for the 400 volt. Additional neutral bushing shall also be provided for earthing.

4.5 Off Circuit Tap Changing Equipment

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

4.6 Marshalling Box

A metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IEC: 60947 Part-1.

4.7 Cable boxes
Whenever cable connections are required, suitable cable boxes shall be provided and shall be air insulated. They shall be of sufficient size to accommodate Purchaser's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust & vermin proof.

5.0 Inspection and Testing

a) The Contractor shall draw up and carry out a comprehensive inspection and testing program during manufacture and commissioning of the transformer. The programme shall be duly approved by the Purchaser.

b) The Contractor shall carry out all routine tests on all the transformers as per relevant standards. Type test report shall be submitted for approval during detail engineering.

6.0 Inspection

6.1 Tank and Accessories

a) Physical and dimensional check of transformer tank and accessories.

b) Crack detection of major strength weld seams by dye penetration test.

6.2 Core

a) Physical inspection and check of quality of varnish, if used.

b) Sample testing of core material for checking specific loss, bend properties, magnetisation, characteristics and thickness.

c) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.

d) HV Test

6.3 Insulating Material

a) Sample checks for physical properties of the material

b) Check for dielectric strength

c) Check for the reaction of hot oil on insulating material

6.4 Winding
6.5 **Assembled Transformer**

a) Check complete transformer against approved outline drawing provision for all fittings, finish etc.

b) Jacking test on all the assembled transformers.

6.6 **Oil**

All standard routine tests in accordance with relevant Standards shall be carried out on oil samples taken from the transformer before and after testing of the transformer.

The contractor shall also prepare a comprehensive inspection and testing programme for all bought out sub-contracted items and shall submit the same to the Purchaser for approval. Such programme shall include the following components:

a) Buchholz Relay

b) Winding temperature Indicator

c) Bushings

d) Marshaling Box

e) Tap changer switch

f) Oil temperature indicator

7.0 **Factory Test**

7.1 All standard routine tests in accordance with latest issue of IEC: 60076 shall be carried out on each transformer.

7.2 The transformer shall conform to all the type tests in accordance with latest issues of IEC: 60076. The manufacturer shall submit type tests & additional test reports as listed above as already carried out on transformers of identical design for owner’s acceptance. In such a case validity of type test reports shall be in line with clause 9.2 of Chapter 2-GTR of technical specifications. Following parameters in general shall be ensured for establishment of identical design as per IEC 60076, Part-V.

a) Same Voltage ratio, KVA rating, vector group & impedance.

b) Same conceptual design of core and winding.

c) Same arrangement and geometrical sequence of the main windings.

d) Same type of winding conductors.
7.3 In addition to all type and routine tests, transformer shall also conform to following additional type tests as per IEC: 60076.

a) Measurement of zero sequence impedance
b) Short circuit test
c) Measurement of acoustic noise level. This shall conform to NEMA standard publication TR-1.
d) Measurement of capacitance and tan delta of transformer winding.

e) Test on oil samples as per IS 60296

7.4 All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall be submitted for bought out items.

7.5 High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

7.6 Tank Tests:
   i) Routine Tests: As per IEC: 60076 Part-1 including
   ii) Vacuum Tests: As per IEC: 60076 Part-1
   iii) Pressure Test: As per IEC: 60076 Part-1

7.7 In addition to the above, the following checks should be carried out at manufacturer's works before despatch for all transformers:

a) Check for interchangeability of components of similar transformers and for mounting dimensions.

b) Check for proper packing and preservation of accessories like radiators, bushings explosion vent, dehydrating breather, Buchholz relay, conservator etc.

c) Check for proper provision of bracings to arrest the movements of core and winding assembly inside the tank.

d) Test for gas tightness and derivation of leakage rate. To ensure adequate reserve gas capacity during transit and storage.
7.8 The Contractor shall submit a detailed inspection and testing programme for field activities, covering areas right from the receipt of material stage upto commissioning stage as per IS : 1886 - Code of practice for installation and maintenance of transformers. The indicative checks and tests are given below.

a) Physical checks on each transformer on receipt at site for any damage or short supply.
b) Tests on oil samples
c) Oil leakage test
d) Physical checks for colour of silica in breather
e) Check for oil level in breather housing, conservator tank, etc.
f) Check for correct operation of all protections and alarms.
g) Insulation Resistance Measurement for Main Winding, control wiring etc.
h) Continuously observe the transformer operation at no load for 24 hours.

8.0 Fittings

The following fittings shall be provided with each transformer covered under this specification.
i) Conservator with drain plug and oil filling hole with blanking plate
ii) Plain oil Gauge
iii) Silica gel Breather
iv) Pressure Relief vent
v) Pocket on tank cover for Thermometer
vi) Valves
vii) Earthing Terminals
viii) Rating & Terminal Marking Plates
ix) Lifting Lugs
x) Rollers
xi) Air Release Plug

The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of transformer are deemed to be included.

9.0 Spare Parts

9.1 The list of spares for outdoor type transformers covered under this chapter shall be as specified in Chapter 1- PSR

9.2 In addition, the Bidder shall also recommend optional spare parts and maintenance equipment necessary for three (3) years of successful operation of the equipment. The prices of these shall be indicated in respective schedules and these shall not be considered for the purpose of evaluation.
## 10.0 Technical Specification

<table>
<thead>
<tr>
<th>S No</th>
<th>Description</th>
<th>Unit</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rated Capacity</td>
<td>kVA</td>
<td>630</td>
</tr>
<tr>
<td>2</td>
<td>Rated Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>HV</td>
<td>kV</td>
<td>11</td>
</tr>
<tr>
<td>b)</td>
<td>LV</td>
<td>kV</td>
<td>0.400</td>
</tr>
<tr>
<td>3</td>
<td>Type of Winding</td>
<td></td>
<td>Two Winding</td>
</tr>
<tr>
<td>4</td>
<td>Service</td>
<td></td>
<td>Outdoor</td>
</tr>
<tr>
<td>5</td>
<td>No of Phases</td>
<td>No.</td>
<td>Three</td>
</tr>
<tr>
<td>6</td>
<td>Frequency</td>
<td>Hz</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Type of Cooling</td>
<td></td>
<td>ONAN</td>
</tr>
<tr>
<td>8</td>
<td>Impedance at 75 Deg C</td>
<td>%</td>
<td>0.05</td>
</tr>
<tr>
<td>9</td>
<td>Tolerance on Impedance</td>
<td>%</td>
<td>±10</td>
</tr>
<tr>
<td>10</td>
<td>Duty</td>
<td></td>
<td>Continuous</td>
</tr>
<tr>
<td>11</td>
<td>Overload</td>
<td>IEC:60076-7</td>
<td>IEC:60076-7</td>
</tr>
<tr>
<td>12</td>
<td>Max. Temp. Rise over an ambient of 50 Deg C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Oil (Temperature rise measurement by thermometer)</td>
<td>°C</td>
<td>50</td>
</tr>
<tr>
<td>b)</td>
<td>Winding Temperature rise measurement by resistance method</td>
<td>°C</td>
<td>55</td>
</tr>
<tr>
<td>13</td>
<td>Windings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>System Apparent Short circuit level (kA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per IEC: 60076-Part 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Winding Connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>HV</td>
<td></td>
<td>Delta</td>
</tr>
<tr>
<td>(ii)</td>
<td>LV</td>
<td></td>
<td>Star</td>
</tr>
<tr>
<td>14</td>
<td>Vector Group</td>
<td></td>
<td>Dyn1</td>
</tr>
<tr>
<td>15</td>
<td>Insulation</td>
<td></td>
<td>Uniform</td>
</tr>
<tr>
<td>16</td>
<td>Insulation Level</td>
<td>kVrms</td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Power Frequency Test Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>HV</td>
<td>kVrms</td>
<td>28</td>
</tr>
<tr>
<td>S No</td>
<td>Description</td>
<td>Unit</td>
<td>Parameters</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------</td>
<td>----------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>17</td>
<td>LV Basic Impulse Level</td>
<td>kVrms</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>HV Highest voltage (kV) for each winding</td>
<td>kVp</td>
<td>75</td>
</tr>
<tr>
<td>19</td>
<td>LV Method of earthing</td>
<td>kVp</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>Tap changer</td>
<td></td>
<td>+5% to -10% in step of 2.5% on HV side</td>
</tr>
<tr>
<td>21</td>
<td>HV Bushing</td>
<td></td>
<td>Off Circuit Tap Change Switch</td>
</tr>
<tr>
<td>22</td>
<td>LV &amp; Neutral Bushing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Terminal Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Min. Clearance in Air</td>
<td>mm</td>
<td>280/25</td>
</tr>
</tbody>
</table>

**HV Bushing**

- **Rated Voltage**: 12 kV
- **Rated current**: 100 A
- **Basic Impulse Level (kVp)**: 75 kVp
- **Wet & Dry Power frequency Withstand Voltage**: 28 kVrms
- **Min. Total Creepage Distance**: 300 mm
- **Mounting**: Tank / Transformer Body

**LV & Neutral Bushing**

- **Rated Voltage**: 1.1 kV
- **Rated current**: 1000 A
- **Basic Impulse Level (kVp)**: - kVp
- **Wet & Dry Power frequency Withstand Voltage**: 2 kVrms
- **Mounting**: Tank / Transformer Body

**Terminal Details**

- **HV**: Suitable for 11kV Cable or Over Head Conductor

- **LV & Neutral**: Suitable for 33kV Cable or Over Head Conductor

**Min. Clearance in Air**

- **Ph-Ph (HV/LV)**: 280/25 mm
- **Ph-Earth (HV/LV)**: 140/25 mm
# CHAPTER 8: FIRE PROTECTION

## Table of contents

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Intent Of Specification</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Design And Construction</td>
<td>2</td>
</tr>
<tr>
<td>3.0</td>
<td>Tests</td>
<td>12</td>
</tr>
<tr>
<td>4.0</td>
<td>Spare Parts</td>
<td>15</td>
</tr>
<tr>
<td>5.0</td>
<td>Horizontal Centrifugal Pumps</td>
<td>15</td>
</tr>
<tr>
<td>6.0</td>
<td>Diesel Engines</td>
<td>20</td>
</tr>
<tr>
<td>7.0</td>
<td>Piping, Valves And Specialities</td>
<td>23</td>
</tr>
<tr>
<td>8.0</td>
<td>Air Vessels</td>
<td>31</td>
</tr>
<tr>
<td>9.0</td>
<td>Heat Detectors/Fire Detectors And Spray Nozzles</td>
<td>31</td>
</tr>
<tr>
<td>10.0</td>
<td>Portable And Wheel/ Trolley Mounted Fire Extinguishers</td>
<td>33</td>
</tr>
<tr>
<td>11.0</td>
<td>Instruments</td>
<td>34</td>
</tr>
<tr>
<td>12.0</td>
<td>Electric Motors</td>
<td>37</td>
</tr>
<tr>
<td>13.0</td>
<td>Battery &amp; Battery Chargers</td>
<td>43</td>
</tr>
<tr>
<td>14.0</td>
<td>Control &amp; Annunciation Panels</td>
<td>45</td>
</tr>
</tbody>
</table>
TECHNICAL SPECIFICATION FOR

FIRE PROTECTION SYSTEM

1.0 INTENT OF SPECIFICATION

This section covers the design and performance requirements of the following types of fire protection systems;

a. Hydrant System
b. High Velocity Water (H.V.W) Spray System
c. Fire Detection and alarm System
d. Portable Fire Extinguishers
e. Wheel/ Trolley mounted Fire Extinguishers

1.1.1 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to NFPA norms.

1.1.2 The scope of work include complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for the system, valve pits and pipe supports for buried, entrenched and overground piping.

1.1.3 The equipment offered shall comply with the relevant latest International Standards unless specified otherwise. The Deluge valves, HVW spray nozzles & quartzoid bulb detectors shall have the approval of any of the following agencies;

a. UL of USA.
b. FM of USA
c. LPCB of UK or
d. VDS of Germany,

1.1.4 Ambient temperature for design of all equipment shall be considered as 50°C.

1.1.5 The piping and instruments diagram for Hydrant and HVW spray system for 400kV switchyard is enclosed at Appendix-I. respectively. The successful bidder shall prepare detailed layout and piping drawing based on this drawing and other drawings such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed
2.0 DESIGN AND CONSTRUCTION

2.1 Hydrant System

Hydrant system of fire protection essentially consists of a large network of pipe, both under ground and over ground which feeds pressurised water to a number of hydrant valves, indoor (if applicable) as well as outdoor. These hydrant valves are located at strategic locations near buildings, Transformers and Reactors. Hose pipes of suitable length and fitted with standard accessories like branch pipes, nozzles etc., are kept in Hose boxes. In case of emergency, these hoses are coupled to the respective hydrant valves through instantaneous couplings and jet of water is directed on the equipment on fire. Hydrant protection shall be provided for the following in all substations of voltage levels 132kV and above (This is not applicable for extension of existing 220kV and 132kV substations where Hydrant system is not available). At least one hydrant post shall be provided for every 60m of external wall measurement of buildings.

a) Control room building
b) L.T. Transformer area.
c) Fire Fighting pump House.
d) Stores
e) Transformers
f) Shunt Reactors/ Bus Reactors.

2.1.1 A warning plate shall be placed near the hydrant points for the transformers and reactors substations to clearly indicate that water shall be sprayed only after ensuring that the power to the transformer/ reactor which is on fire is switched off and there are no live parts within 20metres of distance from the personnel using the hydrant.

2.2 HIGH VELOCITY WATER (H.V.W) SPRAY SYSTEM

H.V.W. spray type fire protection essentially consists of a network of projectors and an array of heat detectors around the Transformer/Reactor to be protected. On operation of one or more of heat detectors, Water under pressure is directed to the projector network through a Deluge valve from the pipe network laid for this system. This shall be provided for
transformers and reactors in all 132kV & above substations (This is not applicable for extension of existing 220kV and 132kV substations where HVWS system is not available). Wet detection initiation system shall be employed for automatic operation.

The system shall be designed in such a way that the same can be extended to protect additional Transformer/ Reactor to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer/ Reactor will be on fire. The main header pipe size in the yard shall be 200mmNB(for 220kV & 132kV switchyard). Branch to the equipment (shall not be more than 20metres length) shall be of the same size as of deluge valve.

2.2.1 The Electrical clearance between the Emulsifier system pipe work and live parts of the protected equipment shall not be less than the values given below :

1. 245 kV bushing       2150 mm
2. 145 kV bushing       1300 mm
3. 52 kV bushing        630 mm
4. 36 kV bushing        320 mm

2.2.2 System shall be designed in such a way that the Water pressure available at any spray nozzle shall be between 3.5bar and 5.0bar and shall be demonstrated through hydraulic calculations. Water shall be applied at a minimum rate of 10.2 LPM/M² of the surface area of the transformer / Reactor including radiator, conservator, oil pipes, bushing turrets, etc. (including bottom surface for transformer). The nozzle arrangement shall ensure direct impingement of water on all exterior surfaces of transformer tank, bushing turrets, conservator and oil pipes, except underneath the transformer, where horizontal spray may be provided.

2.2.3 Deluge Valve

Deluge Valve shall be water pressure operated manual reset type. The Deluge valve shall be closed water tight when water pressure in the heat detector pipe work is healthy and the entire pipe work shall be charged with water under pressure upto the inlet of the Deluge valve. On fall of water pressure due to opening of one or more heat detectors, the valve shall open and water shall rush to the spray water network through the open Deluge valve. The valves shall be manually reset to initial position after completion of operation. Each Deluge Valve shall be provided with a water motor gong which shall sound an alarm when water after passing through the Deluge valve, is tapped through the water motor.
Each Deluge valve shall be provided with a local panel with provision of opening of Deluge valve from local and remote from control room/remote centre. In addition to this, each valve shall be provided with local operation latch.

Deluge valves of 100mmNB size shall be used if the flow requirement is \( \leq 200 \text{m}^3/\text{hr} \) and 150mmNB size shall be used for flow requirement \( >200 \text{m}^3/\text{hr} \).

Test valves shall simulate the operation of Deluge valves and shall be of quick opening type. The general construction shall conform to requirements under clause no.7.00.00 for piping, valves and specialities.

### 2.2.4 High Velocity Spray Nozzles (Projectors)

High velocity spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity, which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling.

### 2.2.5 Minimum set point of the heat detectors used in the HVW spray system shall be 79°C. The optimum rating shall, however, be selected by the Bidder, keeping in mind the maximum and minimum temperature attained at site.

### 2.3 Fire Detection and alarm System

This system shall be provided for control room building and Switchyard panel rooms of substations.

#### 2.3.1 Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the entire building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. Each Switchyard panel room shall be considered a separate zone. Adequate number of extra zones shall be provided for Switchyard panel rooms for future bays identified in Single line diagram of the substation. The operation of any of the fire detectors/ manual call point should result in the following;

1. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
2. An audible alarm sounded in the panel, and
3. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
4. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.
2.3.2 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.

2.3.3 Coverage area of each smoke detector shall not be more than 80 m\(^2\) and that of heat detectors shall not be more than 40 m\(^2\). Ionisation type smoke detectors shall be provided in all areas except pantry room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

2.3.4 Cables used should be exclusively for fire detection and alarm system and shall be 2Cx1.5sq.mm Cu. cables. Un-armoured PVC insulated FR cables conforming to latest IEC / International standards shall be used.

2.4 Portable and Wheel/ Trolley mounted Fire Extinguishers

2.4.1 Portable Fire Extinguishers

Adequate number of portable fire extinguishers of pressurised water, dry chemical powder, and Carbon dioxide type shall be provided in suitable locations in control room building and FFPH building as indicated in the drawing. In addition to this one (1) CO2 type fire extinguisher of 4.5kg capacity shall be provided for each Switchyard panel room. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.

The design, construction & testing of portable fire extinguishers shall meet the requirements as per clause 10.00.00.

2.4.2 Wheel/ Trolley mounted Fire Extinguishers

Wheel/Trolley mounted Mechanical foam type fire extinguishers of 50litre capacity, conforming to latest international standards, shall be provided for the protection of the following:

1. Transformers and reactors in 220kV and 132 kV substations where Hydrant/HVWS system is not available. Two (2) nos. for each 220kV or 132kV transformer and reactor.

2. LT transformers in all substations. One (1) no. for each LT transformer.

The design, construction & testing of Mechanical foam type 50 litre capacity shall meet the requirements of relevant International Codes and clause 10.00.00 of this specification.
2.5 Water Supply System

For **220kV and 132kV** level substations water for hydrant & HVW system shall be supplied by one electrical motor driven pump of rated capacity **273m³/hr** at 70MWC head, with another pump of same capacity, driven by diesel engine, shall be used as standby. Water storage tank with two compartments of adequate capacity shall be provided. Pumps shall work under positive suction head. Annunciations of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in control room. Provision for sending data to remote control centre shall also be available.

The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper supporting arrangement. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground. Such locations shall be finalised during detailed engineering.

The whole system will be kept pressurised by providing combination of air vessel and jockey pump of 10.8M³/hr. capacity at 80MWC. The capacity of air vessel shall not be less than 3m³. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. All pumps shall be of horizontal centrifugal type. Pumps and air vessel with all auxiliary equipment will be located in firewater pump house. A pressure relief valve of suitable rating shall be provided in water header to release excess pressure due to atmospheric temperature variations.

Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

2.5.1 The general design of the fire fighting pump sets shall meet the requirements under clauses no.5.00.00 for Horizontal centrifugal pumps, no.6.00.00 for Diesel engines and no.12.00.00 for Electrical motors.

2.5.2 Each pump shall be provided with a nameplate indicating suction lift/delivery head, capacity and number of revolutions per minute.

2.5.3 Design, construction, erection, testing and trial operation of piping, valves, strainers, hydrant valves, hoses, nozzles, branch pipes, hose boxes, expansion joints etc. shall conform to the requirements of clause no. 7.00.00.

2.6 Instrumentation and Control System

2.6.1 All instruments like pressure indicators, differential pressure indicators, pressure switches, level indicators, level switches, temperature indicators, alarms and all other instruments and panels as indicated in the
specification and drawings and those needed for safe and efficient operation of the whole system shall be furnished according to the requirements of clause 11.00.00. Pump running/ fails to start signal shall be taken from the pressure switch immediately after the discharge of the pump.

2.6.2 Control Panel

Power feeder for motors will be from switchgear board located in control building but control supply for all local control panels, annunciation panels, battery charger units, space heaters etc. shall be fed from the AC and DC distribution boards located in pump house. These AC & DC distribution boards will be fed from the switchgears and DCDBs located in control building.

a) Panel for motor driven fire water pump

The panel shall be provided with the following:

1. TPN switch 1 No.
2. Auto/manual selection facility
3. Start/Stop facility with indication lamp 1 Set
4. DOL starter with thermal O/L relay 1 Set
5. Indicating lamp showing power ON 1 Set
6. Indication lamp with drive ON/OF 1 Set
7. Indication lamp showing Motor Trip 1 No.

Additional provisions shall be made for controlling the following from the remote control centre:

1. Auto/manual selection facility
2. Start/Stop facility

Main power cable from breaker feeder of main switchboard shall be terminated in this panel and another cable shall emanate from this panel which shall be terminated at motor terminals.
b) Panel for Two nos. Jockey Pump 1 No.

The panel shall be provided with the following:

1. Fuse-switch unit for Jockey pumps 1 Set for each pump
2. Auto/manual selection facility for each pump
3. Selector switch for selecting either jockey pump 1 No.
4. D.O.L. starter with overload relay self-resetting type, for all the drives. 1 No. each
5. Start/stop push button for Jockey Pump with indication lamp with pad-locking arrangements in stop position 1 Set for each pump
6. Indication lamp for trip indication 1 No. each for pump

Additional provisions shall be made for controlling the following from the remote control centre:

1. Auto/manual selection facility for each pump.

a) Panel for 2 Nos. battery charger & Diesel Engine driven fire water pump 1 No.

The panel shall be provided with the following:

2. Start/Stop facility with indication lamp 1 Set
3. Indicating lamp showing drive ON/OFF 1 Set
4. D.C. Voltmeter/Ammeter in the battery charger circuit 1 No. each
5. Battery charger will be as per specification described 1 Set
6. Selector switch for selecting either of battery chargers for the battery sets. 1 No.

7. Selector switch for selecting either set of batteries for Diesel engine starting. 1 No.

8. Selector switch for boost charging/Trickle charging of battery set. 1 Set

**Additional provisions shall be made for controlling the following from the remote control centre:**

1. Manual Start/Stop of Diesel Engine

**d)** Individual local control panel is to be considered for each transformer/Reactor deluge system wherever these equipment are envisaged. This panel shall contain push buttons with indicating lamps for spray ON/OFF operation in the valve operation circuit. Push buttons shall be concealed behind glass covers, which shall be broken to operate the buttons. Provision shall be made in the panel for the field signal for the annunciations such as spray ON and fire in the Transformer/Reactor. A signal for spray ON shall also be provided in the control room fire alarm panel for employer’s event logger. Remote operation facility to open the Deluge valve from control room/remote centre shall also be provided.

### 2.6.3 Annunciation Panels

a) Location: Fire Water Pump House

i) Indicating lamps showing power supply "ON".

ii) Annunciation windows complete with buttons. Details are as follows:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Electric motor driven fire water pump running</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Electric motor driven fire water pump fails to start</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Diesel engine driven fire water pump running.</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Diesel engine driven water pump fails to start</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Jockey pump-1 running</td>
<td>1</td>
</tr>
</tbody>
</table>
6. Jockey pump-1 fails to start 1
7. Jockey pump-2 running 1
8. Jockey pump-2 fails to start 1
9. Fire in Transformer/ Reactor 1 for each equipment
10. Deluge system operating for Transformer/ Reactor 1 for each equipment
11. Header pressure low 1
12. Fire in smoke detection system zone (Common Fire Signal) 1
13. Water storage tank water level low 2
14. High speed diesel tank level low 1
15. Spare 10

b) **Location: Substation Control Room**

i) Indication lamp showing power supply 'ON'

ii) Provision shall be made in the panel for a signal for spray ON for each Transformer/Reactor for owner's use for event logger.

iii) Each Switchyard panel room shall be considered as separate zone for fire detection and alarm system.

iv) Following annunciations shall be provided.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fire in Transformer/ Reactor</td>
<td>1 for each equipment</td>
</tr>
<tr>
<td>2.</td>
<td>Diesel engine driven fire water pump in operation</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Motor driven fire water pump in operation</td>
<td>1</td>
</tr>
</tbody>
</table>
4. Jockey pump in operation 1
5. Fire fighting Water storage tank level Low 2
6. Fire/Fault (zone alarm module) 1+1(duplicate) For each zone as applicable
7. Spare windows complete in all respect, with relays 10
8. Spare zone alarm modules required for the Number of future A/c Kiosks bays identified as per SLD

-----------------------------------------------------------------------------------------
c) Each annunciation panel shall be provided with a hooter. A hooter in parallel to the hooter in fire panel shall be provided in the security room of substation for alert in case of fire.
d) Indication for fault in respective areas shall also be provided. Each zone alarm module shall exhibit ‘FIRE’ and ‘FAULT’ conditions separately.
e) **Provision for sending data to Remote Control Unit for the following**
   (i) Fire in Switchyard Panel Room (Switchyard Panel room shall be considered as separate zone for fire detection and alarm system).
   (ii) Fire in Transformer/Reactor (1 for each equipment)
   (iii) Diesel engine driven fire water pump in operation.
   (iv) Motor driven fire water pump in operation
   (v) Fire/Fault in Control Room.
   (vi) Water Storage tank level (low and very low for each storage tank).
   (vii) High Speed Diesel tank level (low & very low)
   (viii) AC Mains Supply Healthy/Fail for Main Pump & Jockey Pump
   (ix) DC Control Supply Healthy/Fail for Main Pump & Jockey Pump
   (x) DC Control Supply Healthy/Fail for Diesel Engine driven pump.

2.6.4 The control and interlock system for the fire protection system shall meet the following requirements:
1. Electric Motor Driven Fire water Pump

Pump should start automatically when the System header pressure is low.

Pump should be stopped manually only. Pump should also be started manually if required from local control panel.

2. Diesel Engine Driven Standby Pump

The pump should automatically start under any of the following conditions:

a) System Header pressure low.

b) Electric motor operated fire water pump fails to start.

Pump should be stopped manually only. Pump should also be started manually if required from the local control panel. The battery set which is connected for starting of Diesel engine shall not be subjected to boost charge.

3. Jockey Pump

It shall be possible to select any one of the Jockey pumps as main and the other as standby. Main Jockey pump shall start automatically when water pressure in header falls below the set value. If the main jockey pump fails to start then the standby should start. Jockey pump shall stop automatically when the pressure is restored to its normal value.

Manual starting/stopping shall be possible from the local control panel.

3.0 TESTS

3.1 Shop Tests

3.1.1 Shop tests of all major equipment centrifugal pumps, diesel engines, electrical drive motors, piping, valves and specialties, pressure and storage vessels, MCC, electrical panels, controls, instrumentation etc. shall be conducted as specified in various clauses and as per applicable standards/codes.

3.1.2 Shop tests shall include all tests to be carried out at Contractor's works, works of his sub-contractor and at works where raw materials supplied for manufacture of equipment are fabricated. The tests to be carried out shall include but not be limited to the tests described as follows:
3.1.3 In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Employer.

3.1.4 A comprehensive visual and functional check for panels would be conducted and will include a thorough check up of panel dimensions, material of construction, panel finish, compliance with tubing and wiring specifications, quality of workmanship, proper tagging & locations of instruments/accessories. The wiring check shall be complete point to point ring out and check for agreement with installation drawings and equipment vendor prints of the complete system and an inspection of all field connection terminals and levelling.

3.1.5 All test certificates and reports shall be submitted to the Employer for approval.

3.1.6 The Employer's representative shall be given full access to all tests. The manufacturer shall inform the Employer allowing adequate time so that, if the Employer so desires, his representatives can witness the test.

3.2 Pre-commissioning Tests

3.2.1 General

a) All piping and valves, after installation will be tested hydraulically at a
pressure of 16kg/cm² for a period of 30 minutes to check against leak tightness.

b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever, to the satisfaction of the Employer.

c) All pumps shall be run with the specified fluid from shut off condition to valve wide open condition. Head developed will be checked from the discharge pressure gauge reading. During the test, the pumps and drives shall run smoothly without any undue vibration, leakage through gland, temperature rise in the bearing parts, noise, flow pulsation etc.

d) All pressure vessels should be tested hydraulically at the specified test pressure, singly or in the system.

e) Painting shall be checked by dry type thickness gauges.

f) Visual check on all structural components, welding, painting etc. and if doubt arises, these will be tested again.

g) All test instruments and equipment shall be furnished by the Contractor to the satisfaction of the Employer.

h) Automatic starting of all the fire pumps by operating the test valves.

i) Automatic operation of the Jockey pump

j) Operation of the Deluge valve by breaking a detector as well as manual and remote operation of the deluge valve.

k) Operation of entire annunciation system.

Replacement of fused/damaged quartzoid bulb detectors during the test shall be responsibility of contractor.

3.2.2 After erection at site, the complete HVW spray protection and hydrant system shall be subject to tests to show satisfactory performance for which detailed procedure shall be submitted for Employer's approval.

Full flow tests with water shall be done for the system piping as a means of checking the nozzle layout, discharge pattern and coverage, any obstructions and determination of relation between design criteria and actual performance, also to ensure against clogging of the smaller piping and the discharge devices by foreign matter carried by the water.

Rigidity of pipe supports shall also be checked during the water flow.

3.2.3 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a stream of
hot air/ smoke over the detector. The exact procedure of this test shall be detailed out by the Employer to the successful Bidder.

4.0 SPARE PARTS

The Contractor shall indicate in his scope of supply all the mandatory spares in the relevant schedules. The list of mandatory spares is indicated in ‘Section - Projects’.

5.0 HORIZONTAL CENTRIFUGAL PUMPS

This clause covers the design, performance, manufacturing, construction features and testing of horizontal centrifugal pumps used for the purpose of fire fighting.

5.1 The materials of the various components shall conform to the applicable BS/ASTM/DIN Standards.

5.1.1 In case of any contradiction with the aforesaid standards and the stipulations as per the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail.

5.2 General Performance Requirements

5.2.1 The pump set shall be suitable for continuous operation at any point within the “Range of operation”.

5.2.2 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.2.3 Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. Range of operation shall be 20% of rated flow to 150% of rated flow.

5.2.4 The pump-motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any mal-operation of the system.

5.2.5 Drive Rating

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified.

During starting under reverse flow condition, the motor shall be capable of bringing the pump to rated speed at normal direction with 90% rated voltage at motor terminals.

5.2.6 Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall guided by applicable standards.
5.2.7 The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

5.3 **Design & Construction**

5.3.1 Pump casing may be axially or radially split. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.

5.3.2 Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self-venting & priming. Casing drain, as required, shall be provided complete with drain valves.

5.3.3 Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

5.3.4 Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.

5.3.5 **Impeller**

The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft impellers shall be secured to the shaft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation.

5.3.6 **Wearing Rings**

Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. Suitable method of locking the wearing ring shall be used.

5.3.7 **Shaft**

Shaft size selected shall take into consideration the critical speed, which shall be at least 20% away from the operating speed. The critical speed shall also be at least 10% away from runaway speed.

5.3.8 **Shaft Sleeves**

Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.

5.3.9 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.
5.3.10 **Bearings**

Bearings of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its "Range of Operation" and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.3.11 **Stuffing Boxes**

Stuffing box design shall permit replacement of packing without removing any part other than the gland. Stuffing boxes shall be sealed/cooled by the fluid being pumped and necessary piping, fittings, valves, instruments, etc. shall form an integral part of the pump assembly.

5.3.12 **Shaft Couplings**

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.3.13 **Base Plates & Sole Plate**

A common base plate mounting both for the pump and drive shall be furnished.

The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.3.14 **Material of Construction**

All materials used for pump construction shall be of tested quality. Material of construction of the major parts of the pumps shall be as given below or superior as per relevant latest International standards:

- **a)** Casing: Casting Grade 17 of BS 1452
- **b)** Impeller: Bronze Grade LG2-C of BS1400
- **c)** Wearing ring: Bronze Grade LG2-C of BS1400
- **d)** Shaft: Mild Steel.
- **e)** Shaft sleeve: Bronze Grade LG2-C of BS1400
- **f)** Stuffing box: 2.5% Nickel CI Grade 17 of BS 1452
g) Gland --- do ---

5.3.15 **Balancing**

All rotating components shall be statically and dynamically balanced at shop.

5.3.16 All the components of pumps of identical parameters supplied under this specification shall be interchangeable.

5.4 **Tests and Inspection**

5.4.1 The manufacturer shall conduct all routine tests required to ensure that the equipment furnished conform to the requirements of this specification and are in compliance with the requirements of applicable Codes and Standards. The particulars of the proposed tests and the procedures for the tests shall be submitted to the Employer/Engineer for approval before conducting the tests.

5.4.2 Where stage inspection is to be witnessed by Employer, in addition to above, the Bidder shall submit to the Employer/Engineer at the beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Employer or his authorised inspecting agency are required at the shop.

5.4.3 **Material of Construction**

All materials used for pump construction shall be of tested quality. Materials shall be tested as per the relevant standards and test certificates shall be made available to the Employer/Engineer.

5.4.4 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.

5.4.5 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.

5.4.6 **Hydraulic test at shop**

All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.

5.4.7 **Performance test at shop**
Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the ASME Power Test Code PTC 8.2/BS- 599/I.S.S., latest edition. Routine tests shall be done on all the pumps.

5.4.8 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.

5.4.9 Tests shall preferably be conducted alongwith the actual drives being supplied.

5.4.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.

5.4.11 In case of model testing, the stipulations of latest edition of applicable standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e. sigma values of prototype and model is to be kept same.

5.4.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.

5.4.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.

5.4.14 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.

5.4.15 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

5.4.16 **Pre commissioning tests.**

After installation, pumps offered may be subjected to testing at field also by Employer. If the performances at field are not found to meet the requirement, then the equipment shall be rectified by the Contractor without any extra cost. Prior to performance testing, the procedure for such tests will be mutually agreed between Employer and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.
6.0 DIESEL ENGINES

This Clause covers the design, performance, manufacturing construction features and testing of compression ignition diesel engines, used primarily for driving centrifugal pumps, used for the purpose of fire fighting.

6.1 Design and Construction

General

6.1.1 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.1.2 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be atleast 20% greater than the requirement at the duty point of pump at rated RPM and in no case, less than the maximum power requirement at any condition of operation of pump.

6.1.3 Reference conditions for rated output of engine shall be as per ISO:3046, part I.

6.1.4 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

6.1.5 All parts subjected to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

6.1.6 Starting

The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP.

Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent, special features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

6.1.7 If provision for manual start (cranking) is provided, all controls/mechanisms, which have to be operated during the starting process, shall be within easy reach of the operator.

6.1.8 Automatic cranking shall be effected by a D.C. motor having high starting torque to overcome full engine compression. Starting power will be supplied from either of the two (2) sets of storage batteries. The automatic starting arrangement shall include a 'Repeat Start' feature for 3 attempts. The battery capacity shall be adequate for 3 (three) consecutive starts without recharging with a cold engine under full compression.
6.1.9 The batteries shall be used exclusively for starting the diesel engine and be kept fully charged all the time in position. Arrangement for both trickle and booster charge shall be provided.

Diesel engine shall be provided with two (2) battery charger units of air-cooled design. The charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be made so that any one of the charger units can be utilised for charging either of the two (2) batteries.

6.1.10 For detail design of battery and battery charger, sub-section Electrical may be referred to.

6.1.11 **Governing System:**

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.1.12 The governor shall offer following features:

a) Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

b) Engine shall be provided with an over speed shut-down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol.II, NFPA, 1978).

6.1.13 The governor shall be suitable for operation without external power supply.

6.1.14 **Fuel System**

The diesel engine will run on High Speed Diesel.

6.1.15 The engine shall be provided with fuel oil tank of 250 litres capacity. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Employer.

6.1.16 The fuel oil tank shall be of welded steel constructed to relevant standards for mild steel drums. The outlet of the tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.

6.1.17 The fuel oil tank shall be designed in such a way that the sludge and sediment settles down to the tank bottom and is not carried to the injection pump. A small sump shall be provided and fitted with drain plug to take out sludge/sediment and to drain oil. Adequate hand holes (greater than 80 mm size) shall be provided to facilitate maintenance.

6.1.18 Pipeline carrying fuel oil shall be gradually sloped from the tank to the
injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter shall be incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.

6.1.19 The complete fuel oil system shall be designed to avoid any air pocket in any part of the pipe work, fuel pump, sprayers/injectors, filter system etc. No air relief cock is permitted. However, where air relief is essential, plugs may be used.

6.1.20 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.

6.1.21 **Lubricating Oil System**

Automatic pressure lubrication shall be provided by a pump driven by the crank shaft, taking suction from a sump and delivering pressurised oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to the main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc. Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath.

6.1.22 **Cooling Water System**

Direct cooling or heat exchanger type cooling system shall be employed for the diesel engine. Water shall be tapped from the fire pump discharge. This water shall be led through duplex strainer, pressure breakdown orifice and then after passing through the engine, the water at the outlet shall be taken directly to the sump through an elevated funnel.

6.2.00 **Testing & Inspection**

6.2.01 The manufacturer shall conduct all tests required, to ensure that the equipment furnished conforms to the requirement of this sub-section and in compliance with requirements of applicable codes. The particulars of the proposed tests and the procedure for the tests shall be submitted to the Employer for approval before conducting the tests.

6.2.02 At manufacturer’s works, tests shall be carried out during and after completion of manufacture of different component/parts and the assembly as applicable. Following tests shall be conducted.

6.2.03 Material analysis and testing.

6.2.04 Hydrostatic pressure testing of all pressure parts.

6.2.05 Static and dynamic balance tests of rotating parts at applicable over-speed and determination of vibration level.

6.2.06 MPI/DPT on machined parts of piston and cylinder.
6.2.07 Ultrasonic testing of crankshaft and connecting rod after heat treatment.

6.2.08 Dimensional check of close tolerance components like piston, cylinder bore etc.

6.2.09 Calibration tests of all fuel pumps, injectors, standard orifices, nozzles, instruments etc.

6.2.10 Over speed test of the assembly at 120% of rated speed.

6.2.11 Power run test.

6.2.12 Performance test of the diesel engine to determine its torque, power and specific fuel consumption as function of shaft speed. Performance test of the engine shall be carried for 12 hours out of which 1 hour at full load and one hour at 110% overload.

6.2.13 Measurement of vibration & noise.

(i) Measurement of vibration

The vibration shall be measured during full load test as well as during the overload test and limit shall be 100 microns.

(ii) Measurement of noise level

The equivalent 'A' weighted sound level measured at a distance of 1.5 M above floor level in elevation and 1.0 M horizontally from the base of the equipment, expressed in dB to a reference of 0.0002 microbar shall not exceed 93 dBA.

Above tests for vibration shall be repeated at site as pre-commissioning tests.

6.2.14 Adjustment of speed governor as per BS:5514.

6.2.15 Diesel engine shall be subjected to routine tests as per BS:5514.

7.0 PIPING, VALVES AND SPECIALITIES

This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.

7.2.00 Scope

The piping system which shall include but not be limited to the following:

7.2.1 Plain run of piping, bends, elbows, tees, branches, laterals, crosses, reducing unions, couplings, caps, expansion joints, flanges, blank flanges, thrust blocks, anchors, hangers, supports, saddles, shoes, vibration dampeners, sampling connections, hume pipes etc.
7.2.2 Gaskets, ring joints, backing rings, jointing material etc. as required. Also all welding electrodes and welding consumables including special ones, if any.

7.2.3 Instrument tapping connections, stubs etc.

7.2.4 Gate and globe valves to start/stop and regulate flow and swing check valves for one directional flow.

7.2.5 Basket strainers and Y-type strainers

7.2.6 Bolts, nuts, fasteners as required for interconnecting piping, valves and fittings as well as for terminal points. For pipe connections into Owner's R.C.C. works, Bidder will furnish all inserts.

7.2.7 Painting, anti-corrosive coatings etc. of pipes and equipment.

Adequate number of air release valves shall be provided at the highest points in the piping system to vent any trapped air in the system.

7.3 Design

7.3.1 Material of construction of various pipes shall be as follows:

(a) **Buried Pipes**

Mild steel black pipes as per ASTM A53 medium grade suitably lagged on the outside to prevent soil corrosion, as specified elsewhere.

(b) **Overground Pipes normally full of water**

Mild steel black pipes as per ASTM A53 medium grade.

(c) Overground pipes normally empty, but periodic charge of water and for detector line for HVW System.

Mild steel galvanized pipes as per ASTM A53 medium grade.

7.3.2 All fittings to be used in connection with steel pipe lines upto a size of 80 mm shall be as per ASTM A53 Mild steel tubulars and other wrought steel pipe fittings, Heavy grade. Fittings with sizes above 80 mm upto 150 mm shall be fabricated from ASTM A53 Heavy grade pipes or steel plates having thickness not less than those of ASTM A53 Heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated as per ASTM A53 standard. All fitting used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.3.3 Pipe sizes shall not be less than the sizes indicated in the attached drawings.

7.3.4 For steel pipeline, welded construction should be adopted unless specified otherwise.
7.3.6 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.

7.3.9 Gate/sluice valve shall be used for isolation of flow in pipe lines and construction shall be as per BS 5150. Valves shall be of rising spindle type and of PN 1.6 class.

7.3.10 Gate Valves shall be provided with the following:

(a) Hand wheel.

(b) Position indicator.

(c) Locking facility (where necessary).

7.3.11 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.

7.3.12 Globe valves shall be provided with contoured plug to facilitate regulation and control of flow. All other requirements should generally follow those of gate valve.

7.3.13 Non-return valves shall be swing check type. Valves will have a permanent "arrow" inscription on its body to indicate direction of flow of the fluid.

7.3.14 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform hand wheel with floor stand or chain operator shall be provided for the same.

7.3.15 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.

7.3.14 **Basket Strainer**

(a) Basket strainers shall be of 30mesh and have the following materials of construction:


(b) Inside of basket body shall be protected by two (2) coats of heavy duty bitumastic paint.

(c) Strainers shall be Simplex design. Suitable vent and drain connections with valves shall be provided.

(d) Screen open area shall be at least 4 times pipe cross sectional area at inlet.

(e) Pressure drop across strainer in clean condition shall not exceed 1.5 MWC at 410M3/hr (for 765kV/400kV substations) and 1 MWC at 273M3/hr flow (for 220kV & 132kV substations). Pressure drop test
report of strainer of same design shall be furnished.

7.3.15 **Y-type On-line Strainer**

Body shall be constructed of mild steel (tested quality). Strainer wires shall be of stainless steel AISI:316, 30 SWG, 30 mesh.

Blowing arrangement shall be provided with removable plug at the outlet. Screen open area shall be at least 4 times pipe cross-sectional area at inlet.

Pressure drop test report of strainer of same design shall be furnished.

7.3.16 **Hydrant Valve (Outdoor) and Indoor Hydrant Valves (Internal Landing Valves).**

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as per TAC requirement.

Materials of construction shall be as follows or superior:

a) Column pipe M.S. ASTM A53 med. grade.

b) Hydrant Valve

i) Body Stainless steel.

ii) Trim Leaded tin bronze.

iii) Hand Wheel Cast Iron.

iv) Washer, gasket, etc. Rubber.

v) Quick coupling connection Leaded tin bronze

vi) Spring Phosphor Bronze.

vii) Cap and chain Leaded tin bronze

The general design of hydrant valve shall conform to relevant latest international standards.

7.3.17 **Hoses, Nozzles, Branch pipes and Hose boxes**

(a) Hose pipes shall be of reinforced rubber-lined canvas construction with nominal size of 63 MM (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere.

(b) Hosepipes shall be capable of withstanding an internal water pressure of not less than 35.7 kg/cm² without bursting. It must also withstand a
working pressure of 8.5 kg/cm² without undue leakage or sweating.

(c) Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanised mild steel wires and leather bands.

(d) Branch pipes shall be constructed of copper and have rings of leaded tin bronze at both ends. One end of the branch pipe will receive the quick coupling while the nozzles will be fixed to the other end.

(e) Nozzles shall be constructed of leaded tin bronze.

(f) Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends etc.

(g) Hose pipes fitted with quick coupling ends, branch pipes, nozzles spanner etc. will be kept in a hose box, which will be located near point of use.

(h) All instantaneous couplings, as mentioned under clause Nos. 3.03.19, 3.03.20 and 3.03.21 above shall be of identical design (both male and female) so that any one can be interchanged with another. One male, female combination shall get locked in by mere pushing of the two halves together but will provide leak tightness at a pressure of 8 kg/cm² of water. Designs employing screwing or turning to have engagement shall not be accepted.

7.4 Fabrication & Erection

7.4.1 The contractor shall fabricate all the pipe work strictly in accordance with the related approved drawings.

7.4.2 End Preparation

(a) For steel pipes, end preparation for butt welding shall be done by machining.

(b) Socket weld end preparation shall be sawing/machining.

(c) For tees, laterals, mitre bends, and other irregular details cutting templates shall be used for accurate cut.

7.4.3 Pipe Joints

(a) In general, pipes having sizes over 25 mm shall be joined by butt welding. Pipes having 25 mm size or less shall be joined by socket welding/screwed connections. Galvanised pipes of all sizes shall have screwed joints. No welding shall be permitted on GI pipes. Screwed joints shall have tapered threads and shall be assured of leak tightness without using any sealing compound.

(b) Flanged joints shall be used for connections to vessels, equipment,
flanged valves and also on suitable straight lengths of pipe line of strategic points to facilitate erection and subsequent maintenance work.

7.4.4 Overground Piping

(a) Piping to be laid overground shall be supported on pipe rack/supports. Rack/supports details shall have to be approved by Employer/Engineer.

(b) Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of red oxide primer shall be applied. Finally two (2) coats of synthetic enamel paint of approved colour shall be applied.

7.4.5 Buried Pipe Lines

(a) Pipes to be buried underground shall be provided with protection against soil corrosion by coating and wrapping with two coats of coal tar hot enamel paint and two wraps of reinforced fibre glass tissue. The total thickness of coating and wrapping shall not be less than 3 mm. Alternatively corrosion resistant tapes can also be used for protection of pipes against corrosion.

(b) For Coating and wrapping, holiday testing to be performed inline with latest ASTM standards.

(c) Buried pipelines shall be laid with the top of pipe one meter below ground level.

(d) At site, during erection, all coated and wrapped pipes shall be tested with an approved Holiday detector equipment with a positive signalling device to indicate any fault hole breaks or conductive particle in the protective coating.

7.5 General Instruction for Piping Design and Construction

7.5.1 While erecting field run pipes, the contractor shall check, the accessibility of valves, instrument tapping points, and maintain minimum headroom requirement and other necessary clearance from the adjoining work areas.

7.5.2 Modification of prefabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Employer.

7.5.3 Welding

(i) Welding shall be done by qualified welders only.

(ii) Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.
(iii) Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

(iv) Welding shall be done by manual oxyacetylene or manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of Employer/Consultant.

(v) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

(vi) No backing ring shall be used for circumferential butt welds.

(vii) Welding carried out in ambient temperature of 5°C or below shall be heat-treated.

(viii) Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.

Electrodes size for tack welding shall be selected depending upon the root opening.

(ix) Tacks should be equally spaced as follows:

- for 65 NB and smaller pipes: 2 tacks
- for 80 NB to 300 NB pipes: 4 tacks
- for 350 NB and larger pipes: 6 tacks

(x) Root run shall be made with respective electrodes/filler wires. The size of the electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

(xi) Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.

(xii) The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

(xiii) On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

(xiv) Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld
joints.

7.6 **Tests at Works**

7.6.1 **Pipes**

(i) Mechanical and chemical tests shall be performed as required in the codes/standards.

(ii) All pipes shall be subjected to hydrostatic tests as required in the codes/standards.

(iii) 10% spot Radiography test on welds of buried pipes shall be carried out as per ASME VIII.

7.6.2 **Valves**

(i) Mechanical and chemical tests shall be conducted on materials of the valve as required in the codes/standards.

(ii) All valves shall be tested hydrostatically for the seat as well as required in the code/standards for a period of ten minutes.

(iii) Air test shall be conducted to detect seat leakage.

(iv) Visual check on the valve and simple operational test in which the valve will be operated thrice from full open to full close condition.

(v) No repair work on CI valve body, bonnet or wedge shall be allowed.

7.6.3 **Strainers**

(i) Mechanical and chemical tests shall be conducted on materials of the strainer.

(ii) Strainers shall be subjected to a hydrostatic test pressure of 1.5 times the design pressure or 10 kg/cm²g whichever is higher for a period of one hour.

7.6.4 **Hydrant valves and Indoor Hydrant Valves (Internal Landing Valves)**

(i) The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 kg/cm²g to detect any leakage through defects of casting.

(ii) Flow test shall be conducted on the hydrant valves at a pressure of 7 kg/cm²g and the flow through the valve shall not be less than 900 litres/min.

(iii) Leak tightness test of the valve seat shall be conducted at a hydrostatic test pressure of 14 kg/cm²g.
7.6.5 **Hoses, Nozzles, Branch Pipes and Hose Boxes**

Reinforced rubber-lined canvas hoses shall be tested hydrostatically. Following tests shall be included as per relevant latest International standard.

a) Hydrostatic proof pressure test at 21.4 kgf/cm²g

b) Internal diameter

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 21 kg/cm²g for a period of 2½ minutes and shall not show any sign of leakage or sweating.

Dimensional checks shall be made on the hose boxes and nozzle spanners.

8.0 **AIR VESSELS**

8.1 Air vessels shall be designed and fabricated of mild steel as class-II vessels as per BS 5500 for a pressure of 14 kg/cm² and shall be minimum 3 m³ capacity.

8.2 Inside surface of the tank shall be protected by anti-corrosive paints/coatings/linings as required.

8.3 Outside surfaces of the vessels shall be provided with one (1) coat of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

8.4 **Tests & Inspection**

8.4.1 Air vessels shall be hydraulically tested at 21 kg/cm² for a period not less than one (1) hour.

8.4.2 All materials used for fabrication shall be of tested quality and test certificates shall be made available to the Owner.

8.4.3 Welding procedure and Welder’s qualification tests will be carried out as per relevant International Standard.

8.4.4 NDE tests, which will include 100% Radiography on longitudinal seams and spot Radiography for circumferential seams, for pressure vessel will be carried out.

9.0 **HEAT DETECTORS/FIRE DETECTORS AND SPRAY NOZZLES**

9.0.1 **Intent of Specification**

This specification lays down the requirements of the smoke detectors, heat detectors and spray nozzles for use in various sub-systems of the fire protection system.
9.0.2 **Codes and Standards**

All equipment supplied shall conform to internationally accepted codes and standards.

9.1 **Heat Detectors, Quartzoid bulb type.** (Used in HVW spray system)

a) Heat detectors shall be of any approved and tested type. Fusible chemical pellet type heat detectors are however not acceptable.

b) Temperature rating of the heat detector shall be selected by the Bidder taking into consideration the environment in which the detectors shall operate. Minimum set point shall, however, be 79°C.

c) Heat detectors shall be guaranteed to function properly without any maintenance work for a period of not less than twenty five (25) years.

d) The heat detectors shall be mounted on a pipe network charged with water at suitable pressure. On receipt of heat from fire, the heat detector will release the water pressure from the network. This drop in water pressure will actuate the Deluge valve.

9.2 **HVV Spray Nozzles (Projectors)**

High velocity water spray system shall be designed and installed to discharge water in the form of a conical spray consisting of droplets of water travelling at high velocity which shall strike the burning surface with sufficient impact to ensure the formation of an emulsion. At the same time the spray shall efficiently cut off oxygen supply and provide sufficient cooling. Integral non-ferrous strainers shall be provided in the projectors ahead of the orifice to arrest higher size particle, which are not allowed to pass through the projectors.

9.3 **Fire Detectors (Used in fire detection and alarm system)**

9.3.1 Fire detectors shall be approved by FOC-London or similar international authorities.

9.3.2 Both smoke and heat type fire detectors shall be used. Bidder shall clearly indicate the mode of operation of detectors in his proposal.

9.3.3 The set point shall be selected after giving due consideration for ventilating air velocity and cable insulation.

9.3.4 Fire detectors shall be equipped with an integral L.E.D. so that it shall be possible to know which of the detectors has been operated. The detectors, which are to be placed in the space above the false ceiling or in the floor void shall not have the response indicators on the body but shall be provided with remote response indicators.

9.3.5 Approval from competent authority shall be made available for ionisation type smoke detectors. All required accessories shall also be included in the scope of supply.
9.3.6 Fire detectors shall be guaranteed to function properly without any maintenance work for a period of not less than ten (10) years.

10.0 PORTABLE AND WHEEL/ TROLLEY MOUNTED FIRE EXTINGUISHERS

10.0.1 This specification lays down the requirement regarding fire extinguishers of following types:

Portable fire extinguishers.

a) Pressurised water type.

b) Dry chemical powder type

c) Carbon Dioxide type

Wheel/ Trolley mounted fire extinguishers.

a) Mechanical foam type

10.0.2 All the extinguishers offered by the Bidder shall be of reputed make.

10.1 Design and Construction

10.1.1 All the portable extinguishers shall be of freestanding type and shall be capable of discharging freely and completely in upright position.

10.1.2 Each extinguisher shall have the instructions for operating the extinguishers on its body itself.

10.1.3 All extinguishers shall be supplied with initial charge and accessories as required.

10.1.4 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.

10.1.5 All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant International Standards.

10.1.6 Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. Both constant air pressure and the gas pressure type shall conform to their latest relevant International standards.

10.1.7 Dry chemical powder type portable extinguisher shall conform to its latest relevant International standards.

10.1.8 Carbon Dioxide type portable extinguisher and Carbon Dioxide type trolley mounted extinguisher shall conform to their latest relevant International standards.
10.1.9 Wheel/ trolley mounted fire extinguishers of 50 litre capacity Mechanical foam type shall conform to its latest relevant International standards.

10.2 Tests and Inspection

10.2.1 A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.

10.2.2 Performance testing of extinguisher shall be in line of applicable International Standards. In case where no International Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

10.3 Painting

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant International Standards.

11.0 INSTRUMENTS

11.0.1 Intent of Specification

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

11.0.2 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

11.1 Local Instruments

Pressure/ Differential Gauges & Switches.

11.1.1 The pressure sensing elements shall be continuous 'C' bourdon type.

11.1.2 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand atleast twice the full scale pressure/vacuum without any damage or permanent deformation.

11.1.3 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.

11.1.4 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be
provided.

11.1.5 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.

11.1.6 Weatherproof type construction shall be provided for all gauges. This type of construction shall be fully dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to NEMA-4.

11.1.7 All gauges shall have micrometer type zero adjuster.

11.1.8 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm² and above.

11.1.9 Scales shall be concentric, white with black lettering and shall be in metric units.

11.1.10 Accuracy shall be ± 1.0 percent of full range or better.

11.1.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full scale reading. For pressure gauges and pressure switches, the range shall not be less than 0 -16 Kg/cm².

11.1.12 All gauges shall have 1/2 inch NPT bottom connection.

11.1.13 All instruments shall conform to their latest relevant International standards.

11.1.14 All instruments shall be provided with 3 way gauge isolation valve or cock. Union nut, nipple and tail pipe shall be provided wherever required.

11.1.15 Switch element contact shall have two (2) NO and two (2) NC contacts rated for 240 Volts, 10 Amperes A.C. or 220 Volts, 5 Amperes D.C. Actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch actuation and de-actuation pressures) shall be adjustable. Adjustable range shall be suitable for switch application.

11.1.16 Switches shall be sealed diaphragm, piston actuated type with snap action switch element. Diaphragm shall be of 316 SS.

11.1.18 Necessary accessories shall be furnished.

11.2 Timers

11.2.1 The timers shall be electro-mechanical type with adjustable delay on pick-up or reset as required.

11.2.2 Each timer shall have two pairs of contacts in required combination of NO and NC.

11.3 Level Gauges/Indicator/Switches
11.3.1 **Level Gauges**

i) Gauge glasses shall be used for local level indication wherever shown in the flow diagram.

ii) Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.

iii) Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in visibility.

iv) Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.

v) Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.

vi) Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

11.3.2 **Level Indicators**

i) Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.

ii) AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.

iii) The scale indicator shall be provided at a suitable height for ease of reading.

iv) Accuracy shall be + 1% of scale range or better.

11.3.3 **Level Switches**

i) Level switches shall be of ball float operated magnetic type complete with cage.

ii) Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.

iii) Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within
+ 1.0 percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

11.4 **Solenoid Valves**

11.4.1 The body of the valves shall be Forged brass or stainless steel.

11.4.2 The coil shall be continuous duty, epoxy moulded type Class-F, suitable for high temperature operation.

11.4.3 The enclosure shall be watertight, dust-tight and shall conform to NEMA-4 Standard.

11.4.4 The valves shall be suitable for mounting in any position.

11.5 **Switches, Lamps, Meters Etc.**

All electrical components on the panel namely push buttons, switches, lamps, meters etc. shall meet the requirements of sub-section Electrical enclosed with the specification.

11.6 All local instruments shall be inspected by Employer/Consultant as per the agreed quality plan.

11.7 Makes of control panel and local instruments, accessories shall be as per Employer's approval.

12.0 **ELECTRIC MOTORS**

12.1 **General**

12.1.1 This clause covers the requirements of three phase squirrel cage induction motors and single-phase induction motors.

12.1.2 The motors to be furnished, erected and commissioned as covered under this specification shall be engineered, designed, manufactured, erected, tested as per the requirements specified herein. These requirements shall however be read along with the requirements of the respective driven equipment being supplied under the specification of which this specification forms a part.

12.1.3 The motor supplied under this specification shall conform to the standards specified in GTR.

12.1.4 Terminal point for all motors supplied under this specification shall be at the respective terminal boxes.

12.1.5 Materials and components not specifically stated in this specification but are necessary for satisfactory operation of the motor shall be deemed to be included in the scope of supply of this specification.

12.1.6 Notwithstanding anything stated in this motor specification, the motor has
to satisfy the requirement of the mechanical system during normal and abnormal conditions. For this the motor manufacturer has to co-ordinate with the mechanical equipment supplier and shall ensure that the motor being offered meets the requirements.

12.2 Codes & Standards

12.2.1 The design, manufacture, installation and performance of motors shall conform to the provisions of latest Electricity Act and Electricity Rules. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.

12.2.2 In case of contradiction between this specifications and IEC, the stipulations of this specification shall be treated as applicable.

12.2.3 National Electrical code for hazardous location and relevant NEMA standard shall also be applicable for motors located in hazardous location.

12.3 Design Features

12.3.1 Rating and type

(i) The induction motors shall be of squirrel cage type unless specified otherwise.

(ii) The motors shall be suitable for continuous duty in the specified ambient temperature.

(iii) The MCR KW rating of the motors for 50°C ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

(iv) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars:

a) Rated terminal voltage

From 0.2 to 200 KW 400V (3 Phase, solidly earthed)
Below 0.2 KW 230 V (1 Phase, solidly earthed)

Variation in voltage ± 6%.

b) Frequency 50 Hz ± 3%.

c) Any combination of (a) & (b)

12.3.2 Enclosure

Motors to be installed outdoor and semi-outdoor shall have hose proof
enclosure equivalent to IP-55. For motors to be installed indoor, the enclosure shall be dust proof equivalent to IP-54.

12.3.3 **Cooling method**

Motors shall be TEFC (totally enclosed fan cooled) type.

12.3.4 **Starting requirements**

(i) **Induction motor**

a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IEC 60034.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage condition specified under Clause 12.03.01 (iv) (a) shall be capable of withstanding at least two successive starts with coasting to rest between starts and motor initially at the rated load operating temperature. The motors shall also be suitable for three equally spread starts per hour, the motor initially at a temperature not exceeding the rated operating temperature.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage (clause 12.03.04 (i) (a) by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

12.3.5 **Running requirements**

(i) When the motors are operating at extreme condition of voltage and frequency given under clause no.12.03.01 (iv) the maximum permissible temperature rise over the ambient temperature of 50°C shall be within the limits specified in IEC 60034 after adjustment due to increase ambient temperature specified herein.

(ii) The double amplitude of motor vibration shall be within the limits specified in IEC/International standards. Vibration shall also be within
the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

(iii) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

(iv) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.

(v) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.

(vi) The motors shall be capable of withstanding for 10 seconds without stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.

(vii) Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

12.4 Construction Features

12.4.1 Stator

(i) Stator frame

The stator frames and all external parts of the motors shall be rigid fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of fabrication and machining.

(ii) Stator core

The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibration to minimum.

(iii) Insulation and winding

All insulated winding conductor shall be of copper. The overall motor winding insulation for all 400 volts motors shall be of epoxy thermosetting type i.e., class 'F' but limited to class-B operating from temperature rise consideration. Other motors may be of conventional class-B type. The windings shall be suitable for successful operation in hot, humid, tropical climate with the ambient temperature of 50°C.
12.4.2 Rotor

(i) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by at least 20%.

(ii) Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation.

12.4.3 Terminal box leads

(i) For motors of 400 Volts and below a single terminal box may be provided for power and accessories leads.

(ii) Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

(iii) Terminal box shall be suitable for top and bottom entry of cables.

(iv) Unless otherwise approved, the terminal box shall be capable of being turned through 360° in steps in 90°.

(v) The terminals shall be complete with all accessories for connecting external cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.

(vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.

(vii) Terminal box for single core cable shall be of non-magnetic material.

(viii) Marking of all terminals shall be in accordance with IEC / International standard.

12.4.4 Rating Plates

(i) Rating plates shall be provided for all motors giving the details as called for in IEC 60034 (for three phase squirrel cage induction motors).

(ii) In addition to above, the rating plate shall indicate the following:

a) Temperature rise in °C under normal working conditions.

b) Phase sequence corresponding to the direction of rotation for the application.

c) Bearing identification number (in case of ball/roller bearing) and recommended lubricants.
12.4.5 Other Constructional Features

(i) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of Employer's earthing conductor to be specified to the successful Bidder.

(ii) Motor weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

12.5 Paint and Finish

12.5.1 Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint.

12.5.2 Motor fans shall also be painted to withstand corrosion.

12.5.3 All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated.

12.5.4 Current carrying fasteners shall be either of stainless steel or high tensile brass.

12.6 Tests at Manufacturers Works

12.6.1 Motors shall be subject to routine tests in accordance with IEC 60034.

12.6.2 In addition, the following tests shall also be carried out:

a) 20% over speed test for 2 minutes on all rotors.

b) Measurement of vibration.

c) Measurement of noise level.

d) Phase sequence and polarity checks relative to mechanical rotation.

12.6.3 Tests after installation at site

(i) After installation and commissioning at site, the motors alongwith the driven equipment shall be subject to tests to ascertain their conformity with the requirement of this specification and those of the driven equipment specification and the performance data quoted by the Bidder.

(ii) In case of non-conformity of the motor with these specifications and performance requirement, the Engineer may at his discretion reject or ask for necessary rectification/replacement as detailed in general Terms and Conditions of Contract (GCC) Volume-I.
13.0 BATTERY & BATTERY CHARGERS

This clause covers the design, performance, manufacturing, construction features and testing of Battery and Battery charger used primarily for starting the diesel engine driving the fire water pumps. Battery Chargers shall be housed in Diesel Engine Panel.

13.1 General Information

13.1.1 The equipment specified hereinafter are required for starting the diesel engines and other operation of the plant as required.

13.1.2 For each diesel engine there shall be two (2) sets of Battery and two (2) sets of Battery Charger.

13.1.3 The D.C. voltage shall be obtained normally after necessary rectification by battery charger. The Battery Charging system shall be capable of meeting the following requirements:

13.1.4 Float charging the Battery.

13.1.5 Boost Charging the Battery.

13.1.6 The battery shall be large enough to crank the engine 3 times without charging in between and without getting drained to an extent which will affect its life.

13.1.7 The Bidder shall indicate the battery voltage and battery capacity in Ampere-Hour at ten (10) hour discharge rate. The battery voltage at any time during operation shall not be less than the minimum voltage required for operation of the D.C. loads.

13.2 General Design

The Battery shall be located indoor

13.2.1 Battery

(i) The cells shall be lead-acid type. The Battery shall be automotive type.

(ii) The cells shall be sealed in type with anti-splash type vent plug.

(iii) The cell terminal posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.

(iv) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.

(v) The electrolyte shall be of battery grade Sulphuric Acid. Water for storage batteries conforming to relevant standards shall be used in
the preparation of the electrolyte.

13.2.2 **Battery Charger**

(i) The Bidder shall furnish the battery charging scheme complete with all necessary accessories such as transformers, switches, fuses, starters, contactors, diodes, ammeters, voltmeters and other devices as required for trouble free operation. All devices and equipment shall conform to relevant International Standard or shall be Superior to it.

(ii) The scheme of the battery charger shall be such that the battery can be charged automatically as well as manually.

(iii) The boost charger shall have sufficient capacity to restore a fully discharged Battery to a state of full charge in eight (8) hours with some spare margin over maximum charging rate. Suitable provision shall be kept so that, for a particular engine, any of the two (2) charger units can be used for charging any of the two (2) batteries.

(iv) The instruments, switches and lamps shall be flush/semi-flush mounted on the front panel. Name plate of approved type shall be provided for each of these equipment.

(v) The panel shall be complete with internal wiring and input-output terminal block. Terminal blocks shall be clip on type of suitable rating. All equipment and wire terminals shall be identified by symbols corresponding to applicable schematic/wiring diagram.

(vi) Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.

13.3 **Testing**

13.3.1 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IEC 60146.

13.3.2 Insulation test.

13.3.3 Connection checking.

13.3.4 Measurement of voltage regulation.

13.3.5 Auxiliary of devices.

13.3.6 Alternating current measurement.

13.3.7 Performance test.

13.3.8 Temperature rise test.

13.3.9 Following acceptance tests shall be carried out in batteries as per IEC/International standard.
a) Marking and packing  
b) Verification of dimensions  
c) Test for capacity  
d) Test for voltage during discharge  

Battery and battery charger shall be checked for auto charging and providing sufficient power for three consecutive starting kicks to diesel engine within five minutes with A.C. supply switched off.  

14.0 CONTROL & ANNUNCIATION PANELS  

14.1 Intent of Specification  
The following requirement shall be applicable to the control and annunciation panels furnished under these specifications.  

14.2 General Information  

14.2.1 The equipment specified herein are required for controlling, metering, monitoring and indication of electrical systems of the plant offered.  

14.2.2 The selection and design of all the equipment shall be so as to ensure reliable and safe operation of the plant and shall be subjected to approval by the Employer.  

14.2.3 The reference ambient temperature outside the panel shall be taken as 50°C and relative humidity 100%.  

14.3 Equipment to be Furnished  

Control & annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble free operation of the plant. Details are included in sub-section General.  

14.4 Constructional Details  

14.4.1 The panel frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.  

14.4.2 Panels shall be of free standing type and shall be provided with hinged door with locking arrangement. The access doors, cutest and covers shall be equipped with neoprene/synthetic rubber gaskets (conforming to IEC 60149) all around and the latches sufficiently strong to hold them in alignment when closed. The panels to be installed outdoor or semi outdoor shall have a degree of protection of IP:55 and those installed indoor shall
have a degree of protection of IP:52 as per IEC 60947.

14.4.3 If a panel consists of a number of panels, each panel should be mounted side by side and bolted together to form a compact unit, when two panels meet, the joints shall be smooth, close fittings and un-obstructive.

14.4.4 Removable eye bolt or lifting lugs shall be provided on all panels to facilitate easy lifting.

14.4.5 The heights of all operating equipment on the panel shall be between 800 mm to 1600 mm from the finished floor level. The proper supporting arrangement shall be provided by the Contractor.

14.4.6 Cable entries to the panel may be from bottom or top. The cable entry required will be intimated to the successful Bidder. A suitable removable gland plate of 3 mm thick shall be mounted not less than 200 mm above the floor level.

14.4.7 All equipment mounted on the front face of the panels shall be flush or semi-flush type. All equipment shall be so located that their terminal and adjustment are readily accessible for inspection or maintenance and their removal and replacement can be done without interruption of service to other equipment. The contractor shall submit the panel general arrangement drawings clearly bringing out internal mounting details, dimensions of equipment, clearance between the equipment and the edges of the panel, for approval.

14.5 Name Plates and Labels

14.5.1 Each panel shall be provided with prominent, engraved identification plates for all front mounted equipment. Panel identification name plate shall be provided at front and rear as required.

14.5.2 All name plates shall be of non-rusting metal or 3 ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subjected to Employer's approval.

14.5.3 Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the wiring drawings.

14.6 AC/DC Power Supply

14.6.2 The Employer will provide one feeder each for AC and DC to the panel. The Contractor shall make for his own arrangements for providing these power supplies to different panels.

14.6.3 The Contractor shall provide suitable isolating switch fuse unit in the control panel for receiving the above incoming AC and DC supplies. Fuse and link shall be provided for isolating of individual circuit without disturbing other circuits.

14.7 Wiring
14.7.1 All inter panel wiring and connections between panels (if there is group of panels) including all bus wiring for AC & DC supplies shall be provided by the Contractor.

14.7.2 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour-coded PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires, otherwise similar to the above.

14.7.3 Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

14.7.4 Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Employer/Engineer at the time of detailed engineering.

14.8 Terminal Blocks

14.8.1 Terminal Blocks shall be of 650V grade, rated for 10 Amps and in one-piece moulding. It shall be complete with insulating barriers, clip-on-type terminals, and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be similar to 'Elmex-Standard' type terminals.

14.8.2 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block.

14.8.3 The terminal blocks shall have at least 20% spare terminals.

14.9 Grounding

A continuous copper bus 25 x 3 mm size shall be provided along the bottom of the panel structure. It shall run continuously throughout the length of the panel and shall have provision at both ends for connection to the station grounding grid (25 x 6 mm MS Flat).

14.10 Space Heater and Lighting

14.10.1 Space heaters shall be provided in the panels for preventing harmful moisture condensation.

14.10.2 The space heaters shall be suitable for continuous operation on 230V AC, 50 Hz, single phase supply and shall be automatically controlled by thermostat. Necessary isolating switches and fuses shall also be provided.

14.10.3 Free standing panel shall have a 230V AC, plug point and a fluorescent light operated by door switch.

14.11 Control and Selector Switches

14.11.1 Control and selector switches shall be of rotary type, with escutcheon plates clearly marked to show the function and positions.
14.11.2 Control/selector switches shall be spring return or stay put type as per the requirements. Handles of control/selector switches shall be black in colour. Shape and type of handles shall be to the approval of the Employer.

14.11.3 The contact ratings shall be at least the following:
   
i) Make and carry continuously 10 Amp.
   
ii) Breaking current at 240V DC 1Amp. (Inductive)

iii) Breaking current at 240V DC 5 Amp. at 0.3 p.f. lagging

14.12 Push Buttons

14.12.1 Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 230V AC and 0.5A (Inductive) at 220V DC. The push buttons shall have at least 1 NO and 1 NC contact. All contact faces shall be of silver or silver alloy.

14.12.2 All push buttons shall be provided with integral escutcheon plates marked with its function.

14.12.3 The colour of buttons shall be as follows:

   Green For motor START, Breaker CLOSE, Valve/ damper OPEN.

   Red For motor TRIP, Breaker OPEN, Valve/ damper CLOSE.

   Black For all annunciation functions, overload reset and miscellaneous.

14.12.4 Red push buttons shall always be located to the left of green push buttons. In case of clinker grinder etc. the push buttons would be black-red-green from left to right.

14.13 Indicating Lamps

14.13.1 Indicating lamps shall be of the panel mounting, filament type and of low-watt consumption. Lamps shall be provided with series resistors preferably built-in- the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

14.13.2 Lamp shall have translucent lamp covers of the following colours:

   Red for motor OFF, Valve/damper OPEN, Breaker CLOSED.

   Green for motor ON, Valve/damper CLOSED, Breaker OPEN.

   White for motor AUTO-TRIP.

   Blue for all healthy conditions (e.g. control supply, lub oil pressure and also for spring charged).
Amber for all ALARM conditions (e.g. pressure low, over load and also for 'service' and 'Test' position indication).

14.13.3 Bulbs and lamps covers shall be easily replaceable from the front of the panel.

14.13.4 Indicating lamps should be located directly above the associated push button/control switches. Red lamps shall variably be located to the right of the green lamp. In case a white lamp is also provided, it shall be placed between the red and green lamps. Blue and amber lamps should normally be located above the red and green lamps.

14.14 **Fuses**

14.14.1 All fuses shall be of HRC cartridge plug-in-type and shall be of suitable rating, depending upon circuit requirements.

14.14.2 All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.15 **Contactors**

14.15.1 Contactors shall be of air break, electromagnetic type rated as per requirement.

14.15.2 Operating coils of AC contactors shall be of 230V AC or 220V DC as required. AC contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall not drop out at 70% of the rated voltage.

14.15.3 DC contactors shall have a coil voltage of 220V DC and shall be suitable for satisfactory continuous operation at 80% to 110% of the rated voltage.

14.16 **Relays and Timers**

14.16.1 All auxiliary relays & timers shall be of proven design and of reputed make. Contacts of relays and timers shall be of solid silver or silver cadmium oxide or solid silver faced. Timers shall have the provision to adjust the delay on pick-up or reset as required.

14.16.2 All relays and timers shall have at least two NO and two NC contacts.

14.16.3 All relays and timers shall be suitable for 230V AC and 220V DC as required. DC relays shall operate satisfactorily between 70% to 110% and AC relays shall be suitable for voltage variation between 80% to 110%.

14.17 **Indication Instruments**

14.17.1 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales and shall have an accuracy class of 2.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.
14.17.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment removing or dismantling the instruments.

14.17.3 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

14.17.4 Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

14.18 **Annunciation System**

14.18.1 The annunciation system shall be complete with all necessary relays, flashers and other accessories required for the proper operation of the equipment and shall be completely solid state. The control circuit shall be mounted on plug-in type glass epoxy printed circuit boards. Audible alarms for the system shall be mounted inside the panel. One set of acknowledge, test and reset push buttons shall be mounted on the panel.

14.18.2 Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted (black letters on white background). Each window shall be provided with two lamps.

14.18.3 Audible hooter shall sound when a trouble contact operates and shall continue to sound until the acknowledge button is pressed. In addition to the hooters provided on annunciation panels, a hooter shall be provided outside FFPH which shall sound in any fire alarm condition.

14.18.4 Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.

14.18.5 After acknowledge button is pressed, the hooter and flashing shall stop but the indication lamp shall remain lighted.

14.18.6 After trouble is cleared indication lamps shall be ready and shall go off only when reset.

14.18.7 Silencing the hooter in conjunction with one trouble contact shall not stop and hooter sounding if another trouble contact operates.

14.18.8 When test button is pressed, all lamps shall flash and hooter shall sound.

14.18.9 Annunciator systems shall operate on 220V DC Systems.

14.18.10 The annunciation system shall include alarm for AC control system failure (working on DC supply), DC supply failure (working on AC supply) and test facilities for these alarms.

14.18.11 List of annunciations required on the panels has been listed elsewhere. The Contractor shall also provide additional annunciations if desired by the Employer/Engineer during Vendor drawing review stage and for such additional annunciations no extra charges shall be claimed by the Contractor, if the number of such additions are within 10% of the number stipulated in this specification.
14.18.12 20% spare windows shall be provided on the panel.

14.19 Painting

14.19.1 Painting procedure adopted shall conform to requirements given in GTR. The paint thickness shall not be less than 60 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surface from scratches, grease, dirt and oily spots during testing, transportation handling and erection.

14.20 Tests

14.20.1 Following tests/inspection shall be carried out by the Contractor in the presence of Employer's representative:

(A) Factory Tests

1. Compliance with approved drawings, data and specification.
3. Wiring continuity and functional checks.
4. Calibration of instruments, relays and metres wherever required by inspector.
5. HV test
6. Insulation resistance measurement before and after HV test.

(B) Inspection/Testing at site:

1. IR test before and after HV test
2. HV Test

(C)

1. The Fire detection and annunciation panel shall be subjected to functional tests.
2. The Annunciation System shall be routine tested
# CHAPTER 9: POWER AND CONTROL CABLE

## Table of contents

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Power &amp; Control Cables [For Working Voltages Up To And Including 1100 V]</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Hv Power Cables [For Working Voltages From 3.3 Kv And Including 33 Kv]</td>
<td>5</td>
</tr>
<tr>
<td>3.0</td>
<td>Cable Drums</td>
<td>6</td>
</tr>
<tr>
<td>4.0</td>
<td>Type Tests</td>
<td>6</td>
</tr>
</tbody>
</table>
CHAPTER 9: POWER & CONTROL CABLES

1.0 POWER & CONTROL CABLES [FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]

CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1.1. Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards and for supply for colony lighting from control room.

1.1.2. Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.

1.1.3. For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.

1.1.4. Employer has standardised the sizes of power cables for various feeders. Bidders are to estimate the quantity of cables and quote accordingly. The sizes of power cables to be used per feeder in different application shall be as follows:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>From</th>
<th>To</th>
<th>Cable size</th>
<th>Cable type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Main Switch Board</td>
<td>LT Transformer</td>
<td>2-1(\frac{1}{3})C X 630 mm(^2) per phase</td>
<td>XLPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1-1(\frac{1}{3})C X 630 mm(^2) for neutral</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Main Switch Board</td>
<td>AC Distribution Board</td>
<td>2-3(\frac{1}{2})C X 300 mm(^2)</td>
<td>XLPE</td>
</tr>
<tr>
<td>3.</td>
<td>Main Switch Board</td>
<td>Oil Filtration Unit</td>
<td>1-3(\frac{1}{2})C X 300 mm(^2)</td>
<td>XLPE</td>
</tr>
<tr>
<td>4.</td>
<td>Main Switch Board</td>
<td>Colony Lighting</td>
<td>1-3(\frac{1}{2})C X 300 mm(^2)</td>
<td>XLPE</td>
</tr>
<tr>
<td>5.</td>
<td>Main Switch Board</td>
<td>HVW pump LCP</td>
<td>1-3(\frac{1}{2})C X 300 mm(^2)</td>
<td>XLPE</td>
</tr>
<tr>
<td>6.</td>
<td>Main Switch Board</td>
<td>Main Lighting distribution board</td>
<td>2-3(\frac{1}{2})C X 300 mm(^2)</td>
<td>XLPE</td>
</tr>
<tr>
<td>7.</td>
<td>AC Distribution Board</td>
<td>D.G. Set AMF Panel</td>
<td>2-3(\frac{1}{2})C X 300 mm(^2)</td>
<td>XLPE</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Model</td>
<td>Details</td>
<td>Material</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>-------------</td>
<td>----------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>8</td>
<td>AC Distribution Board</td>
<td>Emergency</td>
<td>1-3½C X 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>distribution</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>AC Distribution Board</td>
<td>ICT MB</td>
<td>1-3½C X 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>10</td>
<td>AC Distribution Board</td>
<td>Bay MB</td>
<td>1-3½C X 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>11</td>
<td>Bay MB</td>
<td>AC Kiosk</td>
<td>1- 3 ½ x 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>12</td>
<td>AC Distribution Board</td>
<td>Battery Charger</td>
<td>1-3½C X 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>13</td>
<td>DCDB</td>
<td>Battery</td>
<td>2-1C X 150 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>14</td>
<td>DCDB</td>
<td>Battery Charger</td>
<td>2-1C X 150 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>15</td>
<td>DCDB</td>
<td>Protection/PLCC panel</td>
<td>1-4C X 16 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>16</td>
<td>Main Lighting DB</td>
<td>Lighting panels (Indoor)</td>
<td>1-3½C X 35 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>17</td>
<td>Main Lighting DB</td>
<td>Lighting panels (outdoor)</td>
<td>1-3½C X 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>18</td>
<td>Main Lighting DB</td>
<td>Receptacles (Indoor)</td>
<td>1-3½C X 35 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>19</td>
<td>Main Lighting DB</td>
<td>Receptacles (Outdoor)</td>
<td>1-3½C X 70 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>20</td>
<td>Lighting Panel</td>
<td>Sub lighting panels</td>
<td>1-4C X 16 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>21</td>
<td>Lighting Panel</td>
<td>Street Lighting Poles</td>
<td>1-4C X 16 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>22</td>
<td>Lighting Panel/ Sub lighting panels</td>
<td>Lighting Fixtures (Outdoor)</td>
<td>1-2C X 6 mm²</td>
<td>PVC</td>
</tr>
<tr>
<td>23</td>
<td>Bay MB</td>
<td>Equipments</td>
<td>1-4C X 16 mm² /1-4C X 6 mm² /1-2C X 6 mm²</td>
<td>PVC</td>
</tr>
</tbody>
</table>

1.1.5 Bidder may offer sizes other than the sizes specified in clause 1.1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser’s approval.

1.1.6 Cables shall be laid as per relevant IEC/International Standards.
1.1.7 While preparing cable schedules for control/protection purpose following shall be ensured:

1.1.7.1 Separate cables shall be used for AC & DC.

1.1.7.2 Separate cables shall be used for DC1 & DC2.

1.1.8 For different cores of CT & CVT separate cable shall be used

1.1.9 Atleast one (1) cores shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

1.1.10 For control cabling, including CT/VT circuits, 2.5 sq.mm. size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further for potential circuits of energy meters separate connections by 2 cores of 2.5 sq.mm. size shall be provided.

1.1.11 Technical data requirement sheets for cable sizes are being enclosed at Annex-I.

1.2. TECHNICAL REQUIREMENTS

1.2.1. General

1.2.1.1. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

1.2.1.2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3 phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases at rated conductor temperature ( 70 degC for PVC insulated cables and 90 degC for XLPE insulated cables). The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

1.2.1.3. The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

1.2.1.4. The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for
conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.

1.2.1.5. The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

1.2.1.6. Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

1.2.1.7. Strip wire armouring method shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.

1.2.1.8. The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

1.2.1.9. All the cables shall pass fire resistance test as per IEC: 60502 (Part-I)

1.2.1.10. The normal current rating of all PVC insulated cables shall be as per IEC: 60502.

1.2.1.11. Repaired cables shall not be accepted.

1.2.1.12. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

1.2.2. **XLPE Power Cables**

1.2.2.1. The XLPE insulated cables shall be of FR type, C1 category conforming to IEC: 60502 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC to type ST-2 of IEC: 60502. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC to Type ST-2 of IEC: 60502 for all XLPE cables.

1.2.3. **PVC Power Cables**

1.2.3.1. The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IEC: 60502 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IEC: 60502. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC.
The outer sheath shall be extruded PVC to Type ST-1 of IEC: 60502 for all cables.

1.2.4. PVC Control Cables

1.2.4.1. The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IEC: 60502 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IEC: 60502. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IEC: 60502 and shall be grey in colour.

1.2.4.2. Cores shall be identified as per IEC: 60502 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per IEC: 60502 (Part-1).

2.0 HV POWER CABLES [FOR WORKING VOLTAGES FROM 3.3 kV AND INCLUDING 33 kV]

2.1. HV POWER CABLE FOR AUXILIARY POWER SUPPLY

The HV cable of 1Cx185 mm² (Aluminium Conductor) or 1Cx120mm² (Copper Conductor) of voltage class as specified for 630 kVA LT transformer for interconnecting 630kVA LT transformer to the NEA feeder shall be, XLPE insulated, armoured cable conforming to IEC: 60502 (Part-2). Terminating accessories shall conform to IEC 61442-1997/IEC 60502-4 1998.

2.2. Bidder may offer sizes other than the sizes specified in clause 2.1. In such case sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser’s approval.

2.3. Constructional Requirements

Cable shall have compacted circular Aluminium conductor, Conductor screened with extruded semi conducting compound, XLPE insulated, insulation screened with extruded semi conducting compound, armoured with non-magnetic material, followed by extruded PVC outer sheath (Type ST-2), with FR properties.

2.4 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.

2.5 The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.
2.6 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

3.0 CABLE DRUMS

3.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

3.2 Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. Maximum, One (1) number non standard lengths of cable size(s) may be supplied in drums for completion of project.

3.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

3.4 A clear space of at least 40 mm shall be left between the cables and the lagging.

3.5 Each drums shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

3.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

4.0 TYPE TESTS

4.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IEC.

4.2 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):

4.2.1 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of
acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:

a) Physical tests for insulation
   i) Hot set test
   ii) Shrinkage test

b) Physical tests for outer sheath
   i) Shrinkage test
   ii) Hot deformation
   iii) Heat shock test
   iv) Thermal stability

4.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following tests:

a) Water absorption (gravimetric) test.
b) Ageing in air oven
c) Loss of mass in air oven
d) Short time current test on power cables of sizes 240 sqmm and above on
   i) Conductors.
   ii) Armours.

e) Test for armouring wires/stripss.
f) Oxygen and Temperature Index test.
g) Flammability test.

4.3 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-

4.3.1 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V:

a) Physical tests for insulation and outer sheath
   i) Shrinkage test
   ii) Hot deformation
   iii) Heat shock test
   iv) Thermal stability

b) High voltage test.

4.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following:

a) High voltage test.
b) Ageing in air oven.
c) Loss of mass in air oven.
d) Short time current test on power cables of sizes 240 sqmm and above on
   i) Conductors.
ii) Armours.
   e) Test for armouring wires/straps.
   f) Oxygen and Temperature Index test.
   g) Flammability test.

4.4 XLPE INSULATED HV POWER CABLES (For working voltages from 3.3 kV and including 33 kV)-

4.4.1 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for XLPE insulated HV power cables (as per IEC: 60502 Part-2).

4.5 Terminating/jointing accessories as per IEC 60840:1999/ IEC62067
## CHAPTER 10- AIR CONDITIONING SYSTEM

<table>
<thead>
<tr>
<th>Clause. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Air Conditioning System For Control Room Building.</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Air Conditioning System For Switchyard Panel Rooms.</td>
<td>5</td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 This specification covers supply, installation, testing and commissioning and handing over to NEA of Air conditioning system for the control room building and switch-yard panel rooms.

1.2 Air conditioning units for control room building shall be set to maintain the inside DBT at 24 °C ± 2°C and the air conditioning system for switch-yard panel rooms shall be set to maintain DBT inside switch-yard panel rooms below 24°C.

1.3 Controllers shall be provided in Control room and Battery room for controlling and monitoring the AC units in these rooms as detailed in clause no.2.3.4.

1.4 Each switch-yard panel room shall be provided with temperature transducer to monitor the temperature of the panel room. The Temperature transducer shall have the following specification:

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Air temperature sensor (indoor use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>4 to 20mA</td>
</tr>
<tr>
<td>Temperature range</td>
<td>-5°C to 60°C</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1°C</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.5°C or better.</td>
</tr>
</tbody>
</table>

2 AIR CONDITIONING SYSTEM FOR CONTROL ROOM BUILDING.

2.1 Air conditioning requirement of control room building shall be met using a combination of following types Air Conditioning units as required.

a) Ductable Split unit of 8.5TR.
b) Cassette type split AC units of 3TR.
c) High wall type split AC units of 2TR.

2.2 Scope

The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

2.2.1 Required number of Ductable split type AC units of 8.5 TR capacity with air cooled outdoor condensing unit with semi hermetic/hermetic compressors including refrigerant pipes, controls, thermostats, filters, outlet dampers, etc.

2.2.2 Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.

2.2.3 Required number of High wall type split AC units of 2TR capacity each
complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

2.2.4 Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.

2.2.5 First charge of refrigerant and oil shall be supplied with the unit.

2.2.6 GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.

2.2.7 Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.

2.2.8 All instruments and local control panels alongwith controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.

2.2.9 PVC drain piping from the indoor units upto the nearest drain point.

2.2.10 Supply and erection of Power and control cable and earthing.

2.2.11 MS Brackets for outdoor condensing units, condensers as required.

2.3 Technical specifications.

2.3.1 Ductable split type AC units.

2.3.1.1 Each Split Air conditioner shall have an indoor unit and an outdoor unit, designed to provide free delivery of conditioned air to the conditioned space. The indoor unit shall be suitable for mounting on the ceiling concealed above the false ceiling. Outdoor unit can be placed on the roof. Each unit shall include a primary source of refrigeration for cooling and dehumidification, means for circulation and cleaning air.

2.3.1.2 Cabinet

The cabinets housing the components of indoor units & outdoor units shall be of heavy gauge sheet steel and suitable for floor mounting/mounting from ceiling. The access panels shall be of easily removable type. The entire casing shall be lined with 25mm thick insulation of totally flame proof type. Suitable drain connection shall be provided for removal of condensate collected inside a tray under cooling coil.

2.3.1.3 Compressor

The compressor shall be Semi hermetically/hermetically sealed type and complete with drive motor. The compressor shall be mounted on spring inside the lower most section of the unit so that it is easily accessible for servicing.

2.3.1.4 Condenser
Air cooled condenser of adequate surface area shall be offered. The air cooled condenser shall be made of copper tubes with external fins.

2.3.1.5 Air Handling Fan

The air handling fan shall be centrifugal type complete with belt drive and electric motor.

2.3.1.6 Filter

Pre-filter at the suctions to remove dust particles down to 10 micron size with 90% efficiency and fine filters to remove dust particles down to 5 micron size with 99% efficiency at the outlet. All filters shall be of panel type.

2.3.1.7 Cooling Coil

Cooling coils shall be of direct expansion type and made of heavy gauge copper with aluminium fins. Rows shall be staggered in the direction of airflow. Separate tubings from the distributor shall feed refrigerant uniformly to different sections of the coil.

2.3.1.8 Refrigerant Piping

Refrigerant piping shall be of heavy gauge copper, heavy class seamless M.S. pipe complete with thermostatic expansion valve, liquid strainer, dehydrator, liquid line shut off valve, high and low pressure gauges.

2.3.1.9 Condensate Trays

An adequate method of condensate removal shall be provided. Condensate tray of adequate size, made of corrosion-resistant material or suitably treated with corrosion-resistant coating shall be provided. The tray shall be adequately insulated to avoid condensation over its external surface.

2.3.1.10 Refrigerant Strainer

A refrigerant strainer shall be provided in the liquid line immediately before the expansion device.

2.3.1.11 Vibration Isolator

A minimum of six 25 thick neoprene rubber pads shall be supplied for each unit.

2.3.1.12 Cooling capacity of 8.5TR unit shall not be less than 102000 btu/hr.

2.3.2 Cassette type split AC units.

The Cassette type AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.3.2.1 Outdoor unit shall comprise of hermetically/ semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.
2.3.2.2 Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi-function cordless remote control unit with special features like programmable timer, sleep mode etc.

2.3.2.3 Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and their EER shall not be less than 2.7.

2.3.3 High wall type split AC units

2.3.3.1 The split AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.3.3.2 Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.3.3.3 The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi-function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.

2.3.3.4 Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency rating of 3star or above.

2.3.4 Controllers shall be provided in Control room and Battery room, one controller for each room, to control and monitoring of AC units and shall have the following facilities;

- Standby units shall come in to operation automatically when the running main unit fails
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.
- Following alarms shall be provided:
  a. Compressor On/OFF condition of each unit
  b. Compressor failure of each unit
  c. Power OFF to AC unit
  d. High temperature in room.

2.4 Warranty

All compressors shall have minimum 5 years Warranty from the date of commissioning.
3 AIR CONDITIONING SYSTEM FOR SWITCHYARD PANEL ROOMS.

3.1 Air conditioning system shall be provided in the switchyard panel rooms used for housing control and protection panels. These panel rooms will be located in the switchyard area and generally unmanned. Therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life.

3.2 Air conditioning system is required for maintaining the temperature below 24°C for sub-station control and protection panels. This shall be achieved using Packaged AC units with free cooling arrangement as per clause 3.4. The system shall be designed for 24 Hours, 365 Days of the year operation to maintain the inside Switchyard panel rooms temperature for proper operation of the critical equipment.

3.3 Number and rating of the units for each panel room shall be as follows:

i. For panel room of length not more than 6 metres.: 2 nos. (1 working + 1 standby) AC units of 2TR capacity each.
ii. For panel room of length more than 6 metres.: 2 nos. (1 working + 1 standby) AC units of 3TR capacity each.

3.4 Technical specification for Packaged AC units with Free Cooling.

3.4.1 Each AC unit shall be complete with air cooled condensing unit with scroll compressor, direct expansion type evaporating unit and microprocessor controller. AC units shall be provided with free cooling arrangement. In free cooling mode, the refrigerant cycle of AC unit shall be switched off and outside air (after filtration) shall be circulated inside the conditioned space through the operation of dampers provided with suitable sensors. This mode shall come into operation in the following conditions;

i. When the ambient temperature is below a preset value, which is to be decided during detailed engineering.
ii. In case of failure of refrigeration system of both the units.

3.4.2 One of the air-conditioners shall be running at a time and shall maintain the required temperature. On failure of the running air-conditioner, the other air-conditioner shall start automatically. To ensure longer life of the system and to keep the AC units healthy, change over of the standby unit shall be done periodically through the controller. Further, if inside temperature of the room reaches 35°C due to any emergency condition, the standby air-conditioner shall also start running to maintain the temperature less than 24°C and system shall generate an alarm for such a situation. After achieving this temperature, the standby unit shall again shut off. However any hunting situation shall be reported. No heating or humidification is envisaged for the air conditioning system inside the Switchyard panel rooms.

3.4.3 Packaged AC units with free cooling shall be designed for high sensitive cooling with sensible heat factor of 90% or above.

3.4.4 Each air conditioner shall be completely self-contained. All components of the units shall be enclosed in a powder coated cabinet. The unit shall be assembled, wired, piped, charged with refrigerant and fully factory tested as a system to ensure trouble free installation and start up. Suitable isolation or
other by-passing arrangement shall be provided such that any unit/component could be maintained/ repaired without affecting the running standby unit.

3.4.5 The AC units shall be mounted on the wall and the maintenance of unit shall be possible from outside the Switchyard panel room.

3.4.6 Required Features of Various Components

The compressor shall be very reliable, trouble free and long life i.e. hermetically sealed Scroll type of reputed make suitable for continuous operation. Compressor should be installed on vibration isolated mountings or manufacturer’s recommended approved mounting. Valve shall be provided for charging/topping up of refrigerant. The bidder shall furnish details of their compressor indicating the MTBF, life of compressor and continuous run time of compressor without failure. The contractor shall also furnish details of all accessories i.e. refrigeration system, evaporator coil, condenser coil, evaporator blower, filter, cabinet, indoor supply and return grill etc. during detailed engineering.

3.5 Warranty

All compressors shall have minimum 5 years Warranty from the date of commissioning.

3.6 For owner’s remote monitoring purposes, necessary digital inputs shall be provided for ‘ON’ and ‘OFF’ condition of each compressor.
CHAPTER 11- DIESEL GENERATOR SET

CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.</td>
<td>SCOPE OF SUPPLY</td>
<td>1</td>
</tr>
<tr>
<td>1.2.</td>
<td>SCOPE OF SERVICE</td>
<td>1</td>
</tr>
<tr>
<td>1.3.</td>
<td>TECHNICAL REQUIREMENTS</td>
<td>1</td>
</tr>
<tr>
<td>1.4.</td>
<td>PLANT DESIGN</td>
<td>2</td>
</tr>
<tr>
<td>1.5.</td>
<td>CONTROL AND INSTRUMENTATION</td>
<td>4</td>
</tr>
<tr>
<td>1.6.</td>
<td>D.G. SET ENCLOSURE</td>
<td>6</td>
</tr>
<tr>
<td>1.7.</td>
<td>INSTALLATION ARRANGEMENT</td>
<td>8</td>
</tr>
<tr>
<td>1.8.</td>
<td>DOCUMENTS</td>
<td>8</td>
</tr>
<tr>
<td>1.9.</td>
<td>TESTS</td>
<td>8</td>
</tr>
<tr>
<td>1.10.</td>
<td>COMMISSIONING CHECKS</td>
<td>8</td>
</tr>
</tbody>
</table>
1.1. SCOPE OF SUPPLY

1.1.1. The scope covers supply of Diesel Generator set of stationary type having a net electrical output of 250kVA/100kVA (as applicable) capacity at specified site conditions of 50° C ambient temperature and 100% relative humidity on FOR site basis. DG set shall be equipped with:
(i) Diesel engine complete with all accessories.
(ii) An alternator directly coupled to the engine through coupling, complete with all accessories.
(iii) Automatic voltage regulator.
(iv) Complete starting arrangement, including two nos. batteries & chargers.
(v) Base frame, foundation bolts etc.
(vi) Day tank of 990 Litre capacity.
(vii) Engine Cooling and lubrication system.
(viii) Engine air filtering system.
(ix) Exhaust silencer package.
(x) Set of GI pipes, valves, strainers, unloading hose pipes as required for fuel transfer system from storage area to fuel tank including electrically driven fuel pump.
(xi) All lubricants, consumable, touch up paints etc. for first filing, testing & commissioning at site. The fuel oil for first commissioning will also be provided by the contractor.
(xii) AMF panel for control, metering and alarm.
(xiii) Enclosure for silent type D.G. Set

1.2. SCOPE OF SERVICE

1.2.1. The Contractor shall provide following services:
a) Design, manufacture, shop testing including assembly test.
b) Despatch, transportation to site.
c) Erection, testing & commissioning with all equipments/materials required for the purpose.
d) Drawings, data, design calculations and printed erection, operation & maintenance manual.
e) Certification and compliance for meeting noise level & emission parameters and other requirements in accordance with latest Notification of MOEF.

1.3. TECHNICAL REQUIREMENTS

1.3.1. The rating of DG sets are as follows:

DG set net output after considering deration for engine and alternator separately due to temperature rise in side the enclosure and on account of power reduction due to auxiliaries shall be 250kVA/100kVA (as applicable), 1500RPM, 0.8Pf, 400V, 3 phase, 50Hz. The above ratings are the minimum requirements.

1.3.1.1. DG sets shall also be rated for 110% of full load for 1 hour in every twelve hrs of continuous running.
1.3.2. The output voltage, frequency and limits of variation from open circuit to full load shall be as follows:

- **Voltage variation** ±10% of the set value provision shall exist to adjust the set value between 90% to 110% of nominal voltage of 400V.

- **Frequency** 50 Hz ±2.5%

1.3.3. The Diesel Generator and other auxiliary motor shall be of H class with temperature rise limited to Class-F for temperature rise consideration.

1.3.4. NOISE LEVEL & EMISSION PARAMETERS: These shall be as per latest Notification of MOEF

### 1.4. PLANT DESIGN

#### 1.4.1. DIESEL ENGINE

1.4.1.1. The engine shall comply with the BS 5514/ISO 3046; latest edition

1.4.1.2. Diesel engine shall be turbo charged multicylinder V-type in line type with mechanical fuel injection system.

1.4.1.3. The engine with all accessories shall be enclosed in a enclosure to make it work silently (within permissible noise level) without any degradation in its performance.

1.4.1.4. The Diesel Engines shall be directly water cooled. Cooling of water through radiator and fan as envisaged.

1.4.1.5. The fuel used shall be High Speed Diesel oil (HSD) or Light Diesel Oil (LDO).

#### 1.4.2. AIR SUCTION & FILTRATION

1.4.2.1. Suction of air shall be from indoor for ventilation and exhaust flue gasses will be let out to outside atmosphere, Condensate traps shall be provided on the exhaust pipe.

1.4.2.2. Filter shall be dry type air filter with replaceable elements.

#### 1.4.3. FUEL AND LUBRICATING OIL SYSTEM

1.4.3.1. The engine shall have closed loop lubricating system. No moving parts shall require lubrication by hand prior to the start of engine or while it is in operation.

#### 1.4.4. ENGINE STARTING SYSTEM

1.4.4.1. Automatic electric starting by DC starter motor shall be provided.

#### 1.4.5. FUEL INJECTION AND REGULATOR
1.4.5.1. The engine shall be fitted with electronic governor.

1.4.5.2. The engine shall be fitted with a heavy, dynamically balanced fly wheel suitable for constant speed governor duty.

1.4.6. **ALTERNATOR**

1.4.6.1. The alternator shall comply with IEC 60034; latest edition.

1.4.6.2. The alternator shall be of continuously rated duty, suitable for 400 V, 3 phases, 50 Hz. Power development having brush-less, synchronous, self-excited, self-regulating system.

1.4.6.3. The alternator shall be drip-proof, screen protected as per IP-23 degree of Protection.

1.4.6.4. The rotor shall be dynamically balanced to minimize vibration.

1.4.6.5. The alternator shall be fitted with shaft mounted centrifugal fan.

1.4.6.6. It shall have the winding of class H but limited to Class-F for temperature rise consideration.

1.4.6.7. The Alternator regulator shall be directly coupled to the engine and shall be complete with the excitation system, automatic voltage regulation of +/- 1%, voltage adjusting potentiometer and under/over speed protection.

1.4.6.8. **TERMINAL BOX**

1.4.6.8.1. Six (6) output terminals shall be provided in alternator terminal box. Terminals shall be Suitable for 1 No. of single core, 630 mm$^2$ XLPE cables per phase for 250kVA DG set and 3½Core 300 mm$^2$ XLPE cable for 100kVA DG set. The neutral shall be formed in AMF panel. The generator terminal box shall be suitable to house necessary cables and should be made of non-magnetic material.

1.4.6.9. The alternator with all accessories shall be enclosed in a enclosure to make it work Silently (within permissible noise level)

1.4.7. **COUPLING**

1.4.7.1. The engine and alternator shall be directly coupled by means of self-aligning flexible flange coupling to avoid misalignment.

1.4.7.2. The coupling shall be provided with a protecting guard to avoid accidental contract.

1.4.8. **MOUNTING ARRANGEMENT**

1.4.8.1. The engine and alternator shall be mounted on a common heavy duty, rigid fabricated steel base frame constructed from ISMC of suitable sections.
1.4.8.2. Adequate number of anti-vibration mounting pads shall be fixed on the common base frame on which the engine and the alternator shall be mounted to isolate the vibration from passing on to the common base frame or the foundation of the D.G. Set.

1.4.9. PERIPHERALS

1.4.9.1. FUEL TANK

1.4.9.1.1. The Fuel tank of 990 Litre capacity shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent, an air breather and necessary piping. The tank shall be painted with oil resistant paint and shall be erected in accordance with Nepal Explosive Act. Fuel tank shall be kept outside of enclosure. The fuel piping shall be carried out to connect the D.G set inside.

1.4.9.1.2. For transferring fuel to Fuel tank transfer pump is envisaged. The capacity of transfer pump shall be adequate to fill the day tank in about 30 minutes. Fuel pump shall be electrically driven.

1.4.9.2. BATTERY and BATTERY CHARGER

1.4.9.2.1. Two nos. 24V batteries complete with all leads, terminals and stand shall be provided. Each battery shall have sufficient capacity to give 10 nos. successive starting impulse to the diesel engine.

1.4.9.2.2. The battery charger shall be complete with transformer, suitable rating (400 V, 3 Ph., 50 Hz./230V, 1Ph., 50 Hz) rectifier circuit, charge rate selector switch for “trickle”/‘boost’ charge, D.C. ammeter & voltmeter, annunciation panel for battery charge indication / loading / failures.

1.4.9.2.3. The charger shall float and Boost Charge the battery as per recommendation of manufacturer of battery. The charger shall be able to charge a fully discharged battery to a state of full charge in 8 Hrs. with 25% spare capacity.

1.4.9.2.4. Manual control for coarse and fine voltage variation shall be provided. Float charger shall have built-in load limiting features.

1.4.9.2.5. Ripple shall not be more than 1%(r.m.s) to get smooth DC voltage shall be provided.

1.4.9.2.6. Charger shall be provided with Out-put Voltmeter & Ammeter.

1.4.9.2.7. Changeover scheme for selecting battery and battery charger by changeover switch should be provided.

1.5. CONTROL AND INSTRUMENTATION

1.5.1. Each D.G. Set shall be provided with suitable instruments, interlock and protection arrangement, suitable annunciation and indications etc. for proper start up, control, monitoring and safe operation of the unit. One local AMF control panel alongwith each D.G. set shall be provided by the Supplier to accommodate
these instruments, protective relays, indication lamps etc. The AMF Panel shall have IP-52 degree of Protection as per IEC: 60529.

1.5.2. The D.G. sets shall be provided with automatic start facility to make it possible to take full load within 30 seconds of Power Supply failure.

1.5.3. Testing facility for automatic operation of D.G. Set shall be provided in AMF panel.

1.5.4. A three attempt starting facility using two impulse timers and summation timer for engine shall be proved and if the voltage fails to develop within 40 sec. from receiving the first impulse, the set shall block and alarm to this effect shall be provided in the AMF panel.

1.5.5. Following instruments shall be provided with Diesel Engine
   a) Lub oil pressure gauge
   b) Water temperature thermometers
   c) Engine tachometer/HR
   d) Any other instruments necessary for DG Set operation shall be provided.

1.5.6. DG set shall be capable of being started/ stopped manually from remote as well as local. (Remote START/STOP push button shall be provided in 400V ACDB). However, interlock shall be provided to prevent shutting down operation as long as D.G. Circuit breaker is closed.

1.5.7. The diesel generator shall commence a shutdown sequence whenever any of the following conditions appear in the system :
   a) Overspeed
   b) Overload
   c) High temperature of engine and cooling water
   d) High temperature inside enclosure
   e) Low lube oil pressure
   f) Generator differential protection
   g) Short circuit protection
   h) Under voltage
   i) Over voltage
   j) Further interlocking of breaker shall be provided to prevent parallel operation of DG set with normal station supply.

1.5.8. Following indication lamps for purposes mentioned as under shall be provided in AMF panel :

1.5.8.1. Pilot indicating lamp for the following :
   a) Mains ON
   b) Alternator ON
   c) Charger ON/OFF
   d) Breaker ON/OFF
   e) Main LT Supply ON/OFF

1.5.8.2. Visual annunciation shall be provided for set shut down due to :
   a) engine overheating
   b) low oil pressure
   c) lack of fuel
   d) Set failed to start in 30 secs after receiving the first start impulse
   e) high cooling water temperature
1.5.9. Thermostatically controlled space heaters and cubicle illumination operated by Door Switch shall be provided in AMF panel. Necessary isolating switches and fuses shall also be provided.

1.5.10. AMF panel shall have facility for adjustment of speed and voltage including fine adjustments in remote as well as in local mode.

Following shall also be provided in AMF panel:

a) Frequency meter

b) 3 Nos. single phase CT's for metering

c) 3 Nos. (Provided by LT swgr manufacturer) single phase CT's with KPV 300V & RCT 0.25 ohm for differential protection of DG Set on neutral side only for

d) 250kVA/100kVA.

e) One (1) DC Ammeter (0-40A)

f) One (1) DC Voltmeter (0-30V)

g) One (1) Voltmeter Selector switch

h) One (1) AC Ammeter

i) One (1) AC Voltmeter

j) Three (3) Timers (24V DC)

k) Two (2) Auto/Manual Selector Switch

l) Two (2) Auto/test/Manual Selector Switch

m) Eleven (11) Aux. Contactors suitable for 24V DC

n) One (1) Motorised potentiometer for voltage adjustment

o) Two (2) Set Battery charger as specified in Technical Specification

p) One (1) Set Phase & Neutral busbars.

q) Any other item required for completion of Control scheme shall be deemed to be included.

1.6. D.G. SET ENCLOSURE

1.6.1. General requirements

1.6.1.1. Diesel engine, alternator, AMF panel, Batteries and Chargers shall be installed outdoor in a suitable weather-proof enclosure which shall be provided for protection from rain, sun, dust etc. Further, in addition to the weather proofing, acoustic enclosures shall also be provided such that the noise level of acoustic enclosure DG set shall meet the requirement of MOEF. The diesel generator sets
should also conform to Nepal Environment (Protection) Rules. An exhaust fan with louvers shall be installed in the enclosure for temperature control inside the enclosure. The enclosure shall allow sufficient ventilation to the enclosed D.G. Set so that the body temperature is limit to 50°C. The air flow of the exhaust fan shall be from inside to the outside the shelter. The exhaust fan shall be powered from the DG set supply output so that it starts with the starting of the DG set and stops with the stopping of the DG set. The enclosure shall have suitable viewing glass to view the local parameters on the engine.

1.6.1.2. Fresh air intake for the Engine shall be available abundantly; without making the Engine to gasp for air intake. A chicken mess shall be provided for air inlet at suitable location in enclosure which shall be finalised during detailed engineering.

1.6.1.3. The Enclosure shall be designed and the layout of the equipment inside it shall be such that there is easy access to all the serviceable parts.

1.6.1.4. Engine and Alternator used inside the Enclosure shall carry their manufacturer’s Warranty for their respective Models and this shall not degrade their performance.

1.6.1.5. Exhaust from the Engine shall be let off through Silencer arrangement to keep the noise level within desired limits. Interconnection between silencer and engine should be through stainless steel flexible hose/pipe.

1.6.2. All the Controls for Operation of the D.G. Set shall be easily assessable. There should be provision for emergency shut down from outside the enclosure.

1.6.3. Arrangement shall be made for housing the Battery set in a tray inside the Enclosure.

1.6.4. CONSTRUCTION FEATURES:

1.6.4.1. The enclosure shall be fabricated from at least 14 Gauge CRCA sheet steel and of Modular construction for easy assembling and dismantling. The sheet metal components shall be pre-treated by Seven Tank Process and Powder coated (PURO Polyester based) both-in side and out side – for long life. The hard-ware and accessories shall be high tensile grade. Enclosure shall be given a lasting anti-rust treatment and finished with pleasant environment friendly paint. All the hardware and fixtures shall be rust proof and able to withstand the weather conditions.

1.6.4.2. Doors shall be large sized for easy access and provided with long lasting gasket to make the enclosure sound proof. All the door handles shall be lockable type.

1.6.4.3. The Enclosure shall be provided with anti-vibration pads (suitable for the loads and vibration they are required to carry) with minimum vibration transmitted to the surface the set is resting on.

1.6.4.4. High quality rock wool of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof.

1.6.5. Provision for Neutral/Body Earthing
1.6.5.1. Points shall be available at two side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through insulator mounted on enclosure.
1.7. INSTALLATION ARRANGEMENT

1.7.1. DG set enclosed in enclosure shall be installed on Concrete Pedestal 300mm above FGL.

1.8. DOCUMENTS

1.8.1. Following drawings and data sheet shall be submitted for approval:
   (i) Data sheet for Engine, Alternator, Battery, AMF panel and Enclosure
   (ii) GA drawing of DG set
   (iii) Layout of DG set in the enclosure along with sections
   (iv) GA and schematic of AMF panel
   (v) Arrangement of inclined roof and pedestal.

1.8.2. The DG Set shall be supplied with
   (i) DG Set test certificate
   (iii) Engine Parts Catalogue.
   (v) Alternator test certificate.

1.9. TESTS

   a) The Diesel generator sets shall be tested for routine and acceptance tests as per the relevant IEC standards.

1.10. COMMISSIONING CHECKS

   In addition to the checks and test recommended by the manufacturer, the Contractor shall carryout the following commissioning tests to be carried out at site.

   1. Load Test

   The engine shall be given test run for a period of atleast 6 hours. The set shall be subjected to the maximum achievable load as decided by Purchaser without exceeding the specified DG Set rating:

   During the load test, half hourly records of the following shall be taken:

   a) Ambient temperature.
   b) Exhaust temperature if exhaust thermometer is fitted.
   c) Cooling water temperature at a convenient point adjacent to the water output from the engine jacket.
   d) Lubricating oil temperature where oil cooler fitted.
   e) Lubricating oil pressure.
   f) Colour of exhaust gas
   g) Speed
   h) Voltage, wattage and current output.
   i) Oil tank level
The necessary load to carry out the test shall be provided by the purchaser.

2. Insulation Resistance Test for Alternator

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500V megger shall not be less than \( IR = 2 \times (\text{rated voltage in KV}) + 1 \)

3. Check of Fuel Consumption

A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

4. Insulation Resistance of Wiring

Insulation resistance of control panel wiring shall be checked by 500V Megger. The IR shall not be less than one mega ohm.

5. Functional Tests

a) Functional tests on control panel.
b) Functional test on starting provision on the engine.
c) Functional tests on all Field devices.
d) Functional tests on AVR and speed governor.

6. Measurement of Vibration

The vibration shall be measured at load as close to maximum achievable load and shall not exceed 250 microns.

7. Noise Level shall be less than 75dBA at a distance of one meter.

8. The tests shall be carried out with the DG set operating at rated speed and at maximum achievable load. Necessary correction for Test environment condition & background noise will be applied as per applicable IEC/International Standards.
CHAPTER 12 - SWITCHYARD ERECTION

CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>AAC / ACSR MOOSE CONDUCTOR</td>
<td>13</td>
</tr>
<tr>
<td>3.0</td>
<td>GALVANIZED STEEL EARTH WIRE</td>
<td>18</td>
</tr>
<tr>
<td>4.0</td>
<td>TUBULAR BUS CONDUCTORS</td>
<td>21</td>
</tr>
<tr>
<td>5.0</td>
<td>EARTHING CONDUCTORS</td>
<td>22</td>
</tr>
<tr>
<td>6.0</td>
<td>SPACERS</td>
<td>22</td>
</tr>
<tr>
<td>7.0</td>
<td>BUS POST INSULATORS</td>
<td>24</td>
</tr>
<tr>
<td>8.0</td>
<td>GROUNDING SYSTEM</td>
<td>27</td>
</tr>
<tr>
<td>9.0</td>
<td>MAIN BUS BARS (APPLICABLE FOR ALUMINUM TUBE)</td>
<td>29</td>
</tr>
<tr>
<td>10.0</td>
<td>BAY EQUIPMENT</td>
<td>30</td>
</tr>
<tr>
<td>11.0</td>
<td>EQUIPMENT ERECTION DETAILS</td>
<td>30</td>
</tr>
<tr>
<td>12.0</td>
<td>STORAGE</td>
<td>31</td>
</tr>
<tr>
<td>13.0</td>
<td>CABLING MATERIAL</td>
<td>31</td>
</tr>
<tr>
<td>14.0</td>
<td>DIRECTLY BURIED CABLES</td>
<td>33</td>
</tr>
<tr>
<td>15.0</td>
<td>INSTALLATION OF CABLES</td>
<td>34</td>
</tr>
<tr>
<td>16.0</td>
<td>JUNCTION BOX</td>
<td>38</td>
</tr>
<tr>
<td>17.0</td>
<td>TESTING AND COMMISSIONING</td>
<td>39</td>
</tr>
</tbody>
</table>

ANNEXURE-A  SHORT CIRCUIT FORCES AND SPACER SPAN FOR 220KV GANTRY STRUCTURE

ANNEXURE-B  STANDARD TECHNICAL DATASHEET FOR AAC/ACSR CONDUCTORS, GS EARTHWIRE AND ALUMINIUM TUBE

ANNEXURE-C  CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST
1.0 GENERAL

The detailed scope of work includes design, engineering, manufacture, testing at works, supply on FOR destination site basis, insurance, handling, storage, erection testing and commissioning of various items and works as detailed herein.

This Chapter covers the description of the following items.

A. Supply of

- String insulators and hardware
- AAC / ACSR conductor
- Galvanised Steel Earthwire
- Aluminium Tubular Bus Bars
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Lightning protection materials
- Cabling material
- Other items

B. Erection Of all items

1.1 String Insulators & Hardware

The insulators for suspension and tension strings shall conform to IEC-60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to equivalent international standard. Composite long rod insulator shall conform to IEC: 61109.

1.1.1 Construction Features

1.1.1.1 For porcelain insulators

a) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength markings on porcelain printed and applied before firing.

b) Porcelain used in insulator manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
c) Glazing of the porcelain shall be uniform brown color, free from blisters, burrs and other similar defects.

1.1.1.2 For glass insulators

It shall be made of toughened glass. Glass used for the shells shall be sound, free from defects, flows bubbles, inclusions, etc and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.

1.1.1.3 When operating at normal rated voltage there shall be no electric discharge between conductor and insulator which would cause corrosion or injury to conductors or insulators by the formation of substances due to chemical action. No radio interference shall be caused when operating at normal rated voltage.

1.1.1.4 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized. The zinc used for galvanizing shall be of grade Zn-99.95. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

1.1.1.5 Bidder shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string insulators, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

1.1.1.6 Clamps for insulator strings and Corona Control rings shall be of aluminum alloy as stipulated for clamps and connectors.

1.1.1.7 Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

1.1.1.8 The tension Insulator hardware assembly shall be designed for minimum 12000 kg tensile load for below 765kV. Earth wire tension clamp shall be designed for minimum 1000 kg tensile load with a factor of safety of two (2).

1.1.1.9 The tension string assemblies shall be supplied along with suitable turn buckle. Sag compensation springs if required may also be provided.

1.1.1.10 All hardware shall be bolted type.

1.2 Long Rod Porcelain Insulators

1.2.1 As an alternative to disc insulator, Bidder can offer long rod porcelain insulators strings, with suitable hardware. The combination should be suitable for application specified and should offer the identical/equivalent parameters as would be available from insulator string comprising disc insulators and
hardware combination.

1.2.2 All constructional features specified at Clause 1.1.1 of this Chapter shall also apply to the long rod insulator string.

1.3 Tests

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

1.3.1 Type Tests on Insulator Strings: The test reports for following type tests shall be submitted for approval as per clause 9.0 of Chapter 2 - GTR.

a) Power frequency voltage withstand test with corona control rings under wet condition as per IEC- 60383.

b) Lightning Impulse voltage withstand test with corona control rings under dry condition as per IEC-60383

c) Voltage distribution test (Dry)

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 13% for 220KV suspension and tension insulator strings, 20% and 22% for 132KV suspension and tension insulator strings respectively.

e) Corona Extinction Voltage test (Dry) :- (As per Annexure – C)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 156kV (rms) for 220kV line to ground under dry condition. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

f) RIV Test (Dry)

Under the conditions as specified under (e) above the insulator string alongwith complete hardware fittings shall have a radio interference voltage level below 1000 microvolts at 1 MHz when subjected to 50 Hz AC line to ground voltage of 156kV for 220kV string under dry conditions. The test procedure shall be in accordance with IEC 60437.

g) Mechanical strength test

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the
string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.3.2 Type Tests on Insulators

Type test report for Thermal Mechanical Performance tests as per IEC - 60575, Clause 3 / IEC: 61109, clause 5.1 (for composite long rod insulators) shall be submitted for approval as per clause 9.2 of Chapter 2 - GTR.

1.3.3 Acceptance Tests for Insulators:

a) Visual examination as per IEC-60383/ IEC-61109 clause no. 7.2 (for composite long rod insulators).

b) Verification of Dimensions as per IEC- 60383.

c) Temperature cycle test as per IEC- 60383.

d) Puncture Test as per IEC-60383 (Applicable only for porcelain insulators).

e) Galvanizing Test as per IEC- 60383.

f) Mechanical performance test as per IEC-60575 Cl. 4 / IEC-61109 clause no. 7.2 (for composite long rod insulators).

g) Test on locking device for ball and socket coupling as per IEC-60372(2).

h) Porosity test as per IEC- 60383 (Applicable only for porcelain insulators).

i) Thermal shock test as per IEC-60383 (Applicable only for glass insulators)

1.3.4 Acceptance Test on Hardware Fitting

a) Visual Examination as per Cl. 5.10 of IS:2486 (Part-I).

b) Verification of Dimensions as per Cl. 5.8 of IS : 2486 (Part-I)

c) Galvanising/Electroplating tests as per Cl. 5.9 of IS : 2486 (Part-I).

d) Slip strength test as per Cl 5.4 of IS-2486 (part-I)

e) Shore hardness test for the Elastometer (if applicable as per the value guaranteed by the Bidder).
f) Mechanical strength test for each component (including corona control rings and arcing horns).

The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 1.2.13.1 (g) above should be followed.

g) Test on locking devices for ball and socket coupling as per IEC - 60372(2).

1.3.5 Routine Test on Insulator

a) Visual Inspection as per IEC-60383
b) Mechanical Routine Test as per IEC-60383
c) Electrical Routine Test as per IEC-60383

1.3.6 Routine Test on Hardware Fittings

a) Visual examination as per IEC-61109 (for composite long rod insulators).

b) Mechanical strength Test as per IEC-61109 (for composite long rod insulators).

1.3.7 Test during manufacture on all Components as applicable on insulator

a) Chemical analysis of zinc used for galvanising:

Samples taken from the zinc ingot shall be chemically analyzed. The purity of zinc shall not be less than 99.95%.

b) Chemical Analysis, mechanical hardness tests and magnetic particle inspection for malleable casting:

The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Program.

1.3.8 Test during manufacture on all components as applicable on hardware fittings:

a) Chemical analysis of zinc used for galvanising:

Samples taken from the zinc ingot shall be chemically analyzed. The purity of zinc shall not be less than 99.95%.

b) Chemical analysis, hardness tests and magnetic particle for forgings:

The chemical analysis, hardness tests and magnetic particle
inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

c) Chemical analysis and mechanical hardness tests and magnetic particle inspection for fabricated hardware:

The chemical analysis, hardness tests and magnetic particle inspection for fabricated hardware will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance programme.

1.4 Parameters

1.4.1 Disc Insulators

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>For 220/132kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Type of insulators</td>
<td>Anti Fog type</td>
</tr>
<tr>
<td>b)</td>
<td>Size of insulator units (mm)</td>
<td>255x145 or 280x145</td>
</tr>
<tr>
<td>c)</td>
<td>Electro mechanical strength</td>
<td>120 kN</td>
</tr>
<tr>
<td>d)</td>
<td>Creepage distance of individual insulator units (minimum and as required to meet total creepage distance)</td>
<td>430 mm</td>
</tr>
<tr>
<td>e)</td>
<td>Markings</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>For Porcelain insulators</td>
<td>Markings on porcelain</td>
</tr>
<tr>
<td>ii)</td>
<td>For toughened glass insulators</td>
<td>Markings shall be done on initial parts</td>
</tr>
<tr>
<td>f)</td>
<td>Power frequency puncture withstand voltage</td>
<td>1.3 times the actual wet flashover voltage</td>
</tr>
</tbody>
</table>

1.4.2 INSULATOR STRING

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>220kV</th>
<th>132kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Power frequency withstand voltage of the complete string with corona control ring (wet) – KV rms</td>
<td>460</td>
<td>275</td>
</tr>
<tr>
<td>b)</td>
<td>Lightning impulse withstand Voltage of string with corona control rings (dry) - kVp</td>
<td>± 1050</td>
<td>± 650</td>
</tr>
<tr>
<td>c)</td>
<td>Switching surge withstand voltage of string with corona control rings (wet) - kVp</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>d)</td>
<td>Minimum corona extinction voltage level</td>
<td>156</td>
<td>NA</td>
</tr>
</tbody>
</table>
For tension application, double insulator strings for 220 KV and single insulator strings for 132 kV system shall be used. For suspension purpose single suspension insulator string shall be used for 220 KV & 132 kV system.

1.4.2.1 INSULATOR STRING (33 KV)

a) Power frequency withstand: \(75\) kV

b) Lightning impulse withstand: \(\pm 170\) kVp

c) Power frequency puncture withstand: \(1.3\) times actual wet flashover voltage of the unit

d) Total creepage distance of the complete insulator string (mm): \(900\)

e) Maximum RIV level in micro volts of string with Corona Control rings at 508 kV (rms) for 765 kV, 320 kV (rms) for 400 kV string and 156 kV for 220 kV string across 300 Ohms resistor at 1 MHz

f) Minimum total creepage distance of the insulator string (mm): \(6125\) and \(3625\)

g) Total no. of discs per strings: \(15\) and \(10\)

1.5 COMPOSITE LONG ROD INSULATOR

As an alternative to disc insulator/long rod porcelain, Bidder can also offer composite long rod insulators with suitable hardware.

1.5.1 Details of Composite Long Rod Insulators

1.5.1.1 Contractor shall offer such composite insulators which have proven use under foggy/ humid operational conditions in polluted industrial environment combined with smoke and dust particles. The Bidder shall furnish evidence in the form of certification from the power utilities that the similar type of product supplied to them had been performing satisfactory. The Bidder shall also submit certified test report for an accelerated ageing test of 5000 hours such as that described in Appendix-C of IEC-61109 or test at multiple stresses of 5000 hrs as described in annexure –B of IEC-62217.

1.5.1.2 Insulators shall have sheds of the “open aerodynamic profile without any under ribs” with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-
1.5.2 Ball and socket shall be 20 mm designation for 120 kN & 24 mm designation for 210 kN Insulators in accordance with the standard dimensions stated in IEC:60120. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength markings on each composite insulator rod unit. No negative tolerance shall be applicable to creepage distance of composite insulators.

1.5.3 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. and shall be in accordance with the latest edition of equivalent International standard. The zinc used for galvanizing shall be of purity of 99.95%. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

1.5.4 Materials

1.5.4.1 Core

It shall be a glass-fiber reinforced (FRP rod) epoxy resin rod of high strength. The rod shall be resistant to hydrolysis. Glass fibers and resin shall be optimized. The rod shall be electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

1.5.4.2 Housing & Weathersheds

The FRP rod shall be covered by a sheath of a silicone rubber compound of a thickness of minimum 3mm. The housing & weathersheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core.

The weathersheds of the insulators shall be of alternate shed profile. The weathersheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams/ burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.
1.5.4.3 End Fittings

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron/ spheroidal graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The sealing shall stick to both housing and metal end fitting. The sealing must be humidity proof and durable with time.

End fittings shall have suitable provisions for fixing grading rings at the correct position as per design requirements.

1.5.4.4 Grading Rings

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce radio and TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/exceeding of permissible electrical stress of material.

1.5.2 Tests and Standards

1.5.2.1 Type Tests

The test reports for following type tests on long rod units, components, materials or complete strings shall be submitted for approval as per clause 9.2 of Chapter 2 - GTR.

1.5.2.1.1 On the complete composite Long Rod Insulator String with Hardware Fittings:

a) Power frequency voltage withstand test with corona control rings/grading ring and arcing horns (if provided) under wet condition as per IEC:60383-1993/

b) Switching surge voltage withstand test under wet condition as per IEC:60383-1993.

c) Impulse voltage withstand test under dry condition as per IEC:60383-1993

d) Corona and RIV test under dry condition.

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 156kV (rms) for 220kV line to ground under dry condition. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

Under the conditions as specified above the insulator string alongwith
complete hardware fittings shall have a radio interference voltage level below 1000 microvolts at 1 MHz when subjected to 50 Hz AC line to ground voltage of 156kV for 220kV under dry conditions. The test procedure shall be in accordance with IEC 60437.

e) Mechanical Strength test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

f) Salt-fog pollution withstand test as per IEC: 60507. The salinity level for composite long rod insulators shall be 160 Kg/m3 NACL.

1.5.2.1.2 On Composite Insulator Units

a) Tests on interfaces and connections of metal fittings as per IEC: 61109-2008.

b) Assembled core load time test as per IEC: 61109-2008.

c) Damage limit proof test and test of tightness of interface between end firings and insulator housing as per IEC: 61109-2008

d) High Pressure washing test

The washing of a complete insulator of each E&M rating is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, The washing shall be carried out for 10 minutes. There shall be no damage to the sheath or metal fitting to housing interface.

e) Brittle fracture resistance test

The test arrangement shall be according to Damage limit proof test with simultaneous application of 1N-HNO3 acid directly in contact with naked FRP rod. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm. The rod shall withstand 80% of SML for 96 hours.

f) Dye penetration test as per IEC: 61109-2008

g) Water diffusion test as per IEC: 61109-2008

h) Tracking and erosion test as per IEC: 61109-2008.

i) Hardness test as per IEC: 61109-2008.

k) Flammability test as per IEC: 61109-2008.

l) Silicone content test

   Minimum content of silicone as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Employer & Supplier in Quality Assurance Program.

m) Recovery of Hydrophobicity test

   1. The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.

   2. Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1” x 1”. Continue treating this area for 2 – 3 minutes, operating the tester at maximum output.

   3. Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.

   4. Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

n) Torsion test

   Three complete insulators of each E&M rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimen adequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion test must pass the Dye Penetration Test as per IEC 61109.

o) Accelerated ageing test of 5000hrs as described in appendix-C of IEC 61109 or Test at multiple stresses of 5000 hrs as described in Annex-B of IEC-62217

1.5.2.2 Acceptance Tests:

1.5.2.2.1 For Composite Long Rod Insulators

<table>
<thead>
<tr>
<th></th>
<th>Verification of dimensions</th>
<th>IEC : 61109-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Galvanizing test</td>
<td>IEC : 60383</td>
</tr>
</tbody>
</table>
### 1.5.2.3 Routine Tests

#### 1.5.2.3.1 For Composite Long Rod Insulator Units

<table>
<thead>
<tr>
<th></th>
<th>Parameters</th>
<th>Unit</th>
<th>System Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nominal Voltage</td>
<td>kV</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>Maximum system voltage</td>
<td>kV</td>
<td>245</td>
</tr>
<tr>
<td>2.</td>
<td>BIL (Impulse) (Peak)</td>
<td>kV (Peak)</td>
<td>±1050</td>
</tr>
<tr>
<td>3.</td>
<td>Power frequency withstand voltage (Wet)</td>
<td>kV (rms)</td>
<td>460</td>
</tr>
<tr>
<td>4.</td>
<td>Switching surge withstand voltage (Wet)</td>
<td>kV (rms)</td>
<td>NA</td>
</tr>
<tr>
<td>5.</td>
<td>Minimum Corona extinction voltage at 50 Hz AC system under dry condition</td>
<td>kV (rms) phase to earth</td>
<td>156</td>
</tr>
<tr>
<td>6.</td>
<td>Radio interference voltage at one MHz for phase to earth voltage of 508 KV under dry condition</td>
<td>Micro Volts</td>
<td>1000 (Max)</td>
</tr>
<tr>
<td>7.</td>
<td>Minimum creepage distance</td>
<td>mm</td>
<td>6125</td>
</tr>
<tr>
<td>8.</td>
<td>Electromechanical strength of Insulator Unit</td>
<td>kN</td>
<td>120</td>
</tr>
</tbody>
</table>

In the event of failure of the sample to satisfy the acceptance test(s) specified in 4.2 above, the retest procedure shall be as per IEC 61109.

### Guaranteed Technical Particulars

#### 1.5.3.1 Electrical system Data

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Parameters</th>
<th>Unit</th>
<th>System Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nominal Voltage</td>
<td>kV</td>
<td>220</td>
</tr>
<tr>
<td>2.</td>
<td>Maximum system voltage</td>
<td>kV</td>
<td>245</td>
</tr>
<tr>
<td>3.</td>
<td>BIL (Impulse) (Peak)</td>
<td>kV (Peak)</td>
<td>±1050</td>
</tr>
<tr>
<td>4.</td>
<td>Power frequency withstand voltage (Wet)</td>
<td>kV (rms)</td>
<td>460</td>
</tr>
<tr>
<td>5.</td>
<td>Switching surge withstand voltage (Wet)</td>
<td>kV (rms)</td>
<td>NA</td>
</tr>
<tr>
<td>6.</td>
<td>Minimum Corona extinction voltage at 50 Hz AC system under dry condition</td>
<td>kV (rms) phase to earth</td>
<td>156</td>
</tr>
<tr>
<td>7.</td>
<td>Radio interference voltage at one MHz for phase to earth voltage of 508 KV under dry condition</td>
<td>Micro Volts</td>
<td>1000 (Max)</td>
</tr>
<tr>
<td>8.</td>
<td>Minimum creepage distance</td>
<td>mm</td>
<td>6125</td>
</tr>
<tr>
<td>9.</td>
<td>Electromechanical strength of Insulator Unit</td>
<td>kN</td>
<td>120</td>
</tr>
</tbody>
</table>
2.0 AAC / ACSR MOOSE CONDUCTOR

2.1 Details of AAC Conductor

2.1.1 The contractor shall supply the conductor as per the standard guaranteed technical particulars enclosed in Annexure-B of the technical specification, Chapter 12 – Switchyard Erection and separate approval is not required during detailed engineering.

Owner has also standardized the guaranteed technical particulars for the conductors which are enclosed in Annexure-E of the technical specification, Chapter 12 – Switchyard Erection. The contractor shall supply the conductor as per the standard guaranteed technical particulars.

2.1.2 The details of the AAC Bull conductor are tabulated below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>AAC BULL</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Stranding and wire diameter</td>
<td>mm</td>
<td>61/4.25</td>
</tr>
<tr>
<td>b)</td>
<td>Number of Strands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Aluminium Layer</td>
<td>Nos.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2nd Aluminium Layer</td>
<td>Nos.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3rd Aluminium Layer</td>
<td>Nos.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>4th Aluminium Layer</td>
<td>Nos.</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>5th Aluminium Layer</td>
<td>Nos.</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Total sectional area</td>
<td>Sq.mm</td>
<td>865.36</td>
</tr>
<tr>
<td>d)</td>
<td>Overall diameter</td>
<td>mm</td>
<td>38.25</td>
</tr>
<tr>
<td>e)</td>
<td>Approximate weight</td>
<td>kg/km</td>
<td>2400</td>
</tr>
<tr>
<td>f)</td>
<td>Calculated d.c. resistance at 20oC</td>
<td>Ohm/km</td>
<td>0.0334</td>
</tr>
<tr>
<td>g)</td>
<td>Minimum UTS</td>
<td>kN</td>
<td>139</td>
</tr>
</tbody>
</table>

2.1.3 The details of Aluminium strand are as follows:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>AAC BULL</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Minimum breaking load of strand before stranding</td>
<td>KN</td>
<td>2.23</td>
</tr>
<tr>
<td>b)</td>
<td>Minimum breaking load of strand after stranding</td>
<td>KN</td>
<td>2.12</td>
</tr>
<tr>
<td>c)</td>
<td>Maximum D.C. resistance of strand at 20 deg. Centigrade</td>
<td>Ohm/KM</td>
<td>3.651</td>
</tr>
</tbody>
</table>

2.2 Details of ACSR Conductor

2.2.1 The details of the ACSR Moose conductors shall be as per the standard guaranteed technical particulars enclosed in Annexure-A are tabulated below:
ACSR MOOSE CONDUCTOR:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>ACSR MOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Stranding and wire diameter</td>
<td>mm</td>
<td>54/3.53 (Al)+ 7/3.53 (Steel)</td>
</tr>
<tr>
<td>b)</td>
<td>Number of Strands</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel center</td>
<td>Nos.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1st Steel Layer</td>
<td>Nos.</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>1st Aluminum Layer</td>
<td>Nos.</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2nd Aluminum Layer</td>
<td>Nos.</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>3rd Aluminum Layer</td>
<td>Nos.</td>
<td>24</td>
</tr>
<tr>
<td>c)</td>
<td>Sectional area of Aluminum</td>
<td>Sq. mm</td>
<td>528.5</td>
</tr>
<tr>
<td>d)</td>
<td>Total sectional area</td>
<td>Sq. mm</td>
<td>597.00</td>
</tr>
<tr>
<td>e)</td>
<td>Overall diameter</td>
<td>mm</td>
<td>31.77</td>
</tr>
<tr>
<td>f)</td>
<td>Approximate weight</td>
<td>kg/km</td>
<td>2004</td>
</tr>
<tr>
<td>g)</td>
<td>Calculated d.c. resistance at 20°C</td>
<td>ohm/km</td>
<td>0.05552</td>
</tr>
<tr>
<td>h)</td>
<td>Minimum UTS</td>
<td>kN</td>
<td>161.2</td>
</tr>
</tbody>
</table>

2.2.2 The details of Aluminum strand are as follows:

ACSR MOOSE CONDUCTOR:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>ACSR MOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Minimum breaking load of strand before stranding</td>
<td>KN</td>
<td>1.57</td>
</tr>
<tr>
<td>b)</td>
<td>Minimum breaking load of strand after stranding</td>
<td>KN</td>
<td>1.49</td>
</tr>
<tr>
<td>c)</td>
<td>Maximum D.C. resistance of strand at 20 deg. Centigrade</td>
<td>Ohm/KM</td>
<td>2.921</td>
</tr>
</tbody>
</table>

2.2.3 The details of steel strand are as follows:

ACSR MOOSE CONDUCTOR:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Unit</th>
<th>ACSR MOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Minimum breaking load of strand before stranding</td>
<td>KN</td>
<td>12.86</td>
</tr>
<tr>
<td>b)</td>
<td>Minimum breaking load of strand after stranding</td>
<td>KN</td>
<td>12.22</td>
</tr>
<tr>
<td>c)</td>
<td>Minimum number of twists to be withstood in torsion test when tested on a gauge length of 100 times diameter of wire</td>
<td>Nos.</td>
<td>18 (Before stranding) 16 (Before stranding)</td>
</tr>
</tbody>
</table>
2.3 Workmanship

2.3.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

2.3.2 All the Aluminum and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing.

2.3.3 The steel strands shall be hot dip galvanized and shall have a minimum zinc coating of 260 gms/sq.m. after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation : B 498-74.

2.3.4 The steel strands shall be performed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanization during pre-forming and post-forming operation.

2.4 Joints in Wires

2.4.1 Aluminum Wires

Joints in aluminum wires shall be as per relevant International standard.

2.4.2 Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

2.5 Tolerances

The manufacturing tolerances shall be as per relevant International standard.

A. AAC Bull and AAC Tarantala conductor:

<table>
<thead>
<tr>
<th>a)</th>
<th>Diameter of Aluminium and Steel Strands</th>
<th>AAC BULL</th>
<th>AAC TARANTALA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>Aluminium</td>
<td>4.25 mm</td>
<td>4.29 mm</td>
<td>4.21 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b)</th>
<th>Lay ratio of Conductor</th>
<th>AAC BULL</th>
<th>AAC TARANTALA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Aluminium</td>
<td>6 wire layer</td>
<td>16</td>
<td>10</td>
</tr>
</tbody>
</table>
### B. ACSR Bersimis and ACSR Moose conductor:

#### a) Diameter of Aluminium and Steel Strands

<table>
<thead>
<tr>
<th></th>
<th>ACSR BERSIMIS</th>
<th>ACSR MOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Maximum</td>
</tr>
<tr>
<td>Aluminium</td>
<td>4.57 mm</td>
<td>4.61 mm</td>
</tr>
<tr>
<td>Steel</td>
<td>2.54 mm</td>
<td>2.57 mm</td>
</tr>
</tbody>
</table>

#### b) Lay ratio of Conductor

<table>
<thead>
<tr>
<th></th>
<th>ACSR BERSIMIS</th>
<th>ACSR MOOSE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Steel</td>
<td>6 wire layer</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>Aluminium</td>
<td>8/12 wire layer</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>14/18 wire layer</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>20/24 wire layer</td>
<td>14</td>
<td>10</td>
</tr>
</tbody>
</table>

### 2.6 Materials

#### 2.6.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%.

#### 2.6.2 Steel

The steel wire strands shall be drawn from high carbon steel wire rods and shall conform to the following chemical composition:

<table>
<thead>
<tr>
<th>Element</th>
<th>% Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.50 to 0.85</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.50 to 1.10</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>Not more than 0.035</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Not more than 0.045</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.10 to 0.35</td>
</tr>
</tbody>
</table>

#### 2.6.3 Zinc

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity.

### 2.7 Standard Length

#### 2.7.1 The conductor shall be supplied as required. No joint shall be allowed within a single span of stringing, jumpers and equipment interconnection.

### 2.8 Tests:

#### 2.8.1 The following type, acceptance & routine tests and tests during manufacturing
shall be carried out on the conductor.

2.8.2 **Type Tests**

In accordance with the stipulation of specification, the following type tests reports of the conductor shall be submitted for approval as per clause 9.2 of Chapter 2 - GTR.

a) UTS test on stranded Conductor.

b) Corona extinction Voltage test (dry)

(c) Radio Interference Voltage test (dry)

(d) DC resistance test On stranded conductor

2.8.3 **Acceptance Tests**

a) Visual check for joints, Scratches etc. and Lengths of conductor

b) Dimensional check on Steel and aluminum Strands
c) Check for lay ratios Of various layers
d) Galvanizing test on steel Strands
e) Torsion and Elongation Test on steel strands
f) Breaking load test on Steel and aluminum Strands
g) Wrap test on steel and Aluminum strands
h) DC resistance test on Aluminum strands
i) UTS test on welded Joint of aluminum Strands
NOTE:

All the above tests except test mentioned at (a) shall be carried out on aluminium and steel strands after stranding only.

2.8.4 Routine Tests

a) Check to ensure that the joints are as per specification.

b) Check that there are no cuts, fins etc. on the strands.

c) All acceptance test as mentioned in Clause 2.7.3 above to be carried out on each coil.

2.8.5 Tests during Manufacture

a) Chemical analysis of Zinc used for galvanizing

b) Chemical analysis of Aluminum used for Making aluminum strands

c) Chemical analysis of Steel used for making Steel strands

2.8.6 Sample Batch for Type Testing

The Contractor shall offer material for selection of samples for type testing, only after getting quality assurance plans approved from Owner’s Quality Assurance Department. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Owner.

3.0 GALVANIZED STEEL EARTH WIRE

3.1 Details of Earth wire

3.1.1 The contractor shall supply the earth wire as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Chapter 12 – Switchyard Erection and separate approval is not required during detailed engineering.

Owner has also standardized the guaranteed technical particulars for the earth wire which are enclosed in Annexure-E of the technical specification, Chapter 12 – Switchyard Erection. The contractor shall supply the earthwire as per the standard guaranteed technical particulars.

3.1.2 The basic details of the earth wire are tabulated below:
3.2 Workmanship

3.2.1 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

3.2.2 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.

3.2.3 The steel strands shall be hot dip galvanized (and shall have minimum Zinc coating of 275 gms/sq.m) after stranding of the uncoated wire surface. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand three and a half dips after stranding in standard Preece test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-74.

3.2.4 The steel strands shall be performed and post formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanization during preforming and post forming operation.

3.2.5 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

3.3 Joints in Wires

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no strand joints or strand splices in any length of the completed stranded earth wire.

3.4 Tolerances

The manufacturing tolerance to the extent of the following limits only shall be permitted in the diameter of the individual steel strands and lay length of the earth wire:

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>3.66 mm</td>
<td>3.75 mm</td>
<td>3.57 mm</td>
</tr>
<tr>
<td>Lay length</td>
<td>181 mm</td>
<td>198 mm</td>
<td>165 mm</td>
</tr>
</tbody>
</table>

Other technical details are furnished in of Annexure -E of this Specification.
3.5 **Materials**

3.5.1 **Steel**

The steel wire strands shall be drawn from high carbon steel rods and shall conform to the following requirements as to the chemical composition.

<table>
<thead>
<tr>
<th>Element</th>
<th>% Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>Not more than 0.55</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.4 to 0.9</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>Not more than 0.04</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Not more than 0.04</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.15 to 0.35</td>
</tr>
</tbody>
</table>

3.5.2 **Zinc**

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209 -1979/ Equivalent BS standard.

3.6 **Standard Length**

3.6.1 The earth wire shall be supplied in standard drum length of manufacturer.

3.8 **TESTS**

3.8.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earth wire.

3.8.2 **TYPE TESTS**

In accordance with the stipulation of specification, the following type tests reports of the earthwire shall be submitted for approval as per clause 9.2 of Chapter 2 - GTR.

a) UTS test

b) DC resistance test

3.8.3 **ACCEPTANCE TESTS**

a) Visual check for joints, Scratches etc. and Length of Earth wire

b) Dimensional check

c) Galvanizing test

d) Lay length check

e) Torsion test

f) Elongation test

g) Wrap test

h) DC resistance test
i) Breaking load test

j) Chemical Analysis of steel

3.8.4 ROUTINE TESTS

a) Check that there are no cuts, fins etc. on the strands.

b) Check for correctness of stranding.

3.8.5 TESTS DURING MANUFACTURE

a) Chemical analysis of zinc used for galvanising

b) Chemical analysis of steel

3.8.6 SAMPLE BATCH FOR TYPE TESTING

The Contractor shall offer material for sample selection for type testing, only after getting quality assurance program approved by the Owner. The samples for type testing shall be manufactured strictly in accordance with the Quality Assurance Program approved by the Owner.

4.0 TUBULAR BUS CONDUCTORS

4.1 General

The contractor shall supply the aluminum tubes as per the standard guaranteed technical particulars enclosed in Annexure- E of the technical specification, Chapter 12 – Switchyard Erection and separate approval is not required during detailed engineering. Owner has also standardized the guaranteed technical particulars for the aluminum tube which are enclosed in Annexure- E of the technical specification, Chapter 12 – Switchyard Erection. The contractor shall supply the aluminum tube as per the standard guaranteed technical particulars.

4.2 Constructional Features

4.2.1 For outside diameter (OD) & thickness of the tube there shall be no minus tolerance, other requirements being as per relevant International standard.

4.2.2 The aluminum tube shall be supplied in suitable cut length to minimize wastage.

4.2.3 The welding of aluminum tube shall be done by the qualified welders duly approved by the owner.

4.3 Tests

In accordance with stipulations of the specification, Routine tests shall be conducted on tubular bus conductors. Also the wall thickness and ovality of the tube shall be measured. In addition to the above tests, 0.2% proof tests on both parent metal and Aluminium tube after welding shall be conducted.
4.4 Technical Parameters

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>4&quot; AL. TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Size</td>
<td>4&quot; IPS (EH Type)</td>
</tr>
<tr>
<td>2.</td>
<td>Outer diameter</td>
<td>114.2 mm</td>
</tr>
<tr>
<td>3.</td>
<td>Thickness</td>
<td>8.51 mm</td>
</tr>
<tr>
<td>4.</td>
<td>Cross-sectional area</td>
<td>2825.61 sq.mm</td>
</tr>
<tr>
<td>5.</td>
<td>Weight</td>
<td>7.7 kg/m</td>
</tr>
</tbody>
</table>

5.0 EARTHING CONDUCTORS

5.1 General

The grounding grid shall consist of copper flat conductor cable or stranded copper wire of minimum size (cross sectional area) 160 sq. mm. electrodes shall be 16 mm diameter and 3.0 meter long (min.) copper clad steel. The risers shall consist of copper conductor of adequate size (but not less than 160 sq. mm.)

6.0 SPACERS

6.1 General

The spacers are to be located at a suitable spacing to limit the short circuit forces as per IEC -60865. Wherever Employer's 220kV & 132kV standard gantry structures are being used, the spacer span(s) for different conductor / span configurations and corresponding short circuit forces shall be as per Annexure-D. For strung buses, flexible type spacers shall be used whereas for jumpers and other connections rigid type spacers shall be used.

Wherever Employer's 220kV & 132kV standard gantry structures are not being used, necessary spacer span calculation shall be provided by the contractor during detailed engineering for the approval of Employer.

6.2 Constructional Features

6.2.1 No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.

6.2.2 Spacer design shall be made to take care of fixing and removing during installation and maintenance.

6.2.3 The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

6.3 Tests

Each type of spacers shall be subjected to the following type tests, acceptance tests and routine tests:

6.3.1 Type Tests: Following type test reports shall be submitted for approval as per clause 9.2 of Chapter 2 - GTR.
a) **Clamp slips tests**

The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicable) at a tension of 44.2 kN. One of the clamps of the sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of the conductor shall not slip on the conductor. The permanent displacement between the conductor and the clamp of sample measured after removal of the load shall not exceed 1.0 mm. Similar tests shall be performed on the other clamps of the same sample.

b) Fault current test.

c) **Corona Extinction Voltage Test (Dry).**

This test shall be performed on 220 kV equipment as per procedure mentioned at Annexure - C, Minimum Corona Extinction voltage shall be 156 kV (rms) line to ground for 220 kV spacers.

d) **RIV Test (Dry)**

This test shall be performed as per procedure mentioned at Annexure - C, Maximum RIV level at 156 kV (rms) line to ground for 220 kV spacers shall be 1000 micro volts, across 300 ohm resistor at 1 MHz

e) Resilience test (if applicable)

f) Tension Test

g) Log decrement test (if applicable)

h) Compression test

i) Galvanising test

6.3.2 **Acceptance Test**

a) Visual examination

b) Dimensional verification

c) Movement test

d) Clamp slip test

e) Clamp bolt torque test (if applicable)

f) Assembly torque test

g) Compression test

h) Tension test

i) Galvanising test
j) Hardness test for neoprene (if applicable)
   
The shore hardness of different points on the elastometer surface of cushion grip clamp shall be measured by shore hardness meter. It shall be between 65 to 80.

k) Ultimate Tensile Strength Test
   
The UTS of the retaining rods shall be measured. It shall not be less than 35 kg/Sq. mm.

6.3.3 Routine test
   
a) Visual examination
   
b) Dimensional verification

7.0 BUS POST INSULATORS

The post insulators shall conform in general to latest IEC-60168, IEC 60273 and IEC-60815.

7.1 Constructional Features

7.1.1 Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

7.1.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

7.1.3 Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

7.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile, The shed profile shall also meet the requirements of IEC-60815 for the specified pollution level.

7.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.

7.1.6 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

7.1.7 All ferrous parts shall be hot dip galvanized. The zinc used for galvanizing shall be grade Zn 99.95. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not
produce any noise generating corona under the operating conditions.

7.1.8

a) Every bolt shall be provided with a steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.

b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

c) All bolts and nuts shall be of steel with well-formed hexagonal heads forged from the solid and shall be hot dip galvanized. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

7.1.9

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

7.2

Tests

In accordance with the stipulations of the specification, the post insulators shall be subject to type, acceptance, sample and routine tests as per IEC-60168.

7.2.1

In addition to acceptance/sample/routine tests as per IEC-60168, the following tests shall also be carried out.

a) Ultrasonic test as an acceptance test

b) Soundness test, metallurgical tests and magnetic test on MCI caps and pedestal tests as acceptance test.

c) All hot dip galvanized components shall be subject to check for uniformity of thickness and weight of zinc coating on sample basis.

d) The bending test shall be carried out at 50% minimum failing load in four directions as a routine test and at 100% minimum failing load in four directions as an acceptance test.

e) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

7.2.2

In accordance with the stipulation of specification, the following type tests reports of the post insulators shall be submitted for approval as per clause 9.2 of Chapter 2 - GTR.

a) Power frequency withstand test (dry & wet)

b) Lightning impulse test (dry)
c) Measurement of R.I.V (Dry)

d) Corona extinction voltage test (Dry)

e) Test for deflection under load

f) Test for mechanical strength.

### 7.3 Technical Parameters of Bus Post Insulators.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>245 kV</th>
<th>145 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Type</td>
<td>Solid Core</td>
<td>Solid Core</td>
</tr>
<tr>
<td>b)</td>
<td>Voltage Class (kV)</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>c)</td>
<td>Dry and wet one minute power frequency withstand voltage (kV rms)</td>
<td>460</td>
<td>275</td>
</tr>
<tr>
<td>d)</td>
<td>Dry lightning impulse withstand Voltage (kVp)</td>
<td>+1050</td>
<td>+650</td>
</tr>
<tr>
<td>e)</td>
<td>Wet switching surge withstand voltage (kVp)</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>f)</td>
<td>Max. radio interference voltage (in microvolts) at voltage of 508 kV (rms), 305 kV (rms) and 156 (rms) for 765 kV, 400 kV &amp; 220 kV respectively between phase to ground.</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>g)</td>
<td>Corona extinction voltage (kV rms) (min.)</td>
<td>156</td>
<td>105</td>
</tr>
<tr>
<td>h)</td>
<td>Cantilever Strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Total minimum cantilever strength (Kg)</td>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>(ii)</td>
<td>Total minimum breaking strength (Kg)</td>
<td>1000</td>
<td>720</td>
</tr>
<tr>
<td>i)</td>
<td>Minimum torsional moment</td>
<td>As per IEC-273</td>
<td>As per IEC-273</td>
</tr>
<tr>
<td>j)</td>
<td>Total height of insulator (mm)</td>
<td>2300</td>
<td></td>
</tr>
<tr>
<td>k)</td>
<td>P.C.D Top (mm)</td>
<td>127</td>
<td>127</td>
</tr>
<tr>
<td>Bottom</td>
<td></td>
<td>254</td>
<td>254</td>
</tr>
<tr>
<td>l)</td>
<td>No. of bolts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Bottom</td>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>m)</td>
<td>Diameter of bolt/holes (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td></td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td>Bottom</td>
<td></td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>n)</td>
<td>Pollution level as per IEC-815</td>
<td>Heavy(III)</td>
<td>Heavy(III)</td>
</tr>
<tr>
<td>o)</td>
<td>Minimum total creepage distance for Heavy Pollution (mm)</td>
<td>6125</td>
<td>3165</td>
</tr>
</tbody>
</table>

### 7.3.1 33kV Bus Post Insulators.

<table>
<thead>
<tr>
<th>a)</th>
<th>Type</th>
<th>Solid Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>b)</td>
<td>Voltage class (kV)</td>
<td>36</td>
</tr>
<tr>
<td>c)</td>
<td>Dry and wet one minute power frequency withstand voltage (kV rms)</td>
<td>70</td>
</tr>
</tbody>
</table>
d) Dry lightning impulse 
   Withstand Voltage (kVp) ±170

e) Total minimum cantilever 
   Strength (Kg) 450

f) Minimum torsional moment As per IEC-273

g) Total height of insulator (mm) As per requirement

h) Pollution level as per 
   IEC-815 Heavy (III)

i) Minimum creepage distance for 
   Heavy Pollution (mm) 900

7.3.2 If corona extinction voltage is to be achieved with the help of corona ring or 
any other similar device, the same shall be deemed to be included in the 
scope of the Contractor. Material of Corona ring shall be aluminum/aluminum 
alloy of 63401W grade or equivalent.

8.0 GROUNDING SYSTEM

8.1 GENERAL

This specification covers the design, supply, delivery, installation and testing 
of the complete grounding system as described below. 
The complete station grounding work shall be in accordance with the 
80 and the requirements of this section.

8.2 GROUNDING INSTALLATION FEATURES

8.2.1 The installation shall be complete in all respects for efficient and trouble free 
service. All work shall be carried out in a first class neat workman like 
manner. Grounding conductors shall be handled carefully to avoid kinking and 
cutting of the conductors during laying and installation. All exposed ground 
conductors runs shall be taken in a neat manner, horizontal, vertical and 
parallel to building walls or columns and shall not be laid haphazardly.

8.2.2 For all connections made to equipment or to the structures, the grounding 
conductor, connectors and equipment enclosures shall have good clean 
contact surfaces. Grounding conductor connection to all electrical equipment, 
switchgear, transformers, motors, panels, conduit system, equipment 
enclosures, cable trays, distribution boards, equipment frames, bases, steel 
structure, etc. shall be by pressure type or bolting type connectors.

8.2.3 All lap, cross and tee connections between two grounding conductors shall be 
made by thermowelding process or compression type connector. The various 
joints shall have adequate mechanical strength as well as necessary 
electrical conductivity not less than that of the parent conductors of the joints. 
All accessories for grounding installation shall be of quality and design 
approved by the Employer. The earthing connection between earthing pad of 
equipment/structures shall be made by two earthing leads.
8.2.4 Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300mm below the bottom elevation of such trenches/pipes.

8.2.5 The maximum size of each grid of grounding mat shall not exceed 4X4 meters. The terminals for connecting ground mat and equipment shall be terminated whenever necessary. The new grounding shall be bonded with existing grounding network at the existing Substations.

8.3 GROUNDING CONDUCTOR

Main Ground Grid
The main ground system shall consist of a grounding grid buried minimum 0.6 meter below grade level. The grounding grid shall consist of copper flat conductor cable or stranded copper wire of minimum size (cross sectional area) 160sq. mm.

Ground Electrodes
The ground electrodes shall be 16mm diameter and 3.0 meter long (min.) copper clad steel. These shall be driven into ground and connected to the main ground grid.

8.3.3 Risers
The risers shall consist of copper conductor of adequate size (but not less than 160 sq. mm.) connected at one end to the main ground mat and at the other end to the equipment.

8.4 DESIGN REQUIREMENTS

8.4.1 The Contractor shall measure the soil resistivity in presence of the Employer. Based on the resistivity the contractor shall calculate the total length of buried ground conductor, number of grounding electrode and their depth and spacing to achieve a grounding system resistance of less than 1.0 (One) Ohm.

8.4.2 The Contractor shall calculate the cross-section considering the maximum fault level of 40 kA.

8.4.3 The Contractor shall submit the details of calculations of the grounding system for the Employer's approval. The earthing system shall be of single earthing system for the whole substation i.e. all earthings shall be connected to main earthing grid.

8.5 TESTS

On completion of the installation, either wholly or in sections, it shall be tested in compliance with relevant Code by the Contractor in presence of the Employer. The cost of any test including labor, material and equipment charges shall be borne by the Contractor. If the ground grid resistance can not be obtained as per his design, then additional grounding conductors shall be buried in the earth, or if necessary, buried in treated soil to obtain the required low ground resistance without any additional cost.

8.6 LIGHTNING PROTECTION
The outdoor equipment of the substation and the substation building shall be protected against lightning. The lightning protection shall be achieved by an overhead lightning shield system of galvanized steel wire of 7/3.35 mm, which shall be connected to the main grounding grid by steel conductor of 7/3.35 mm. Lighting mast with electrode length of 2.5mtr (maximum) may be used in switchyard area for lighting protection as per requirement. The above electrode may be connected to the main grounding grid by steel conductor of 7/3.35 mm. The design of the lightning protection system shall be subject to the approval of the Employer.

8.7 DRAWINGS

After award of the Contract, the Contractor shall furnish the grounding layout drawing with dimensions showing the location of grounding grids, electrodes, test link chambers and risers, backed up by necessary calculations for Employer's approval. The work shall have to be started at site only after getting approval from the Employer. If alteration is required for any work done before getting Employer's approval, the same shall have to be done by the Contractor at no extra cost to the Employer.

### STATION GROUNDING SYSTEM

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Main ground grid conductor material</td>
</tr>
<tr>
<td>2.</td>
<td>Main ground grid conductor size ≥</td>
</tr>
<tr>
<td>3.</td>
<td>Cross section of riser conductors ≥</td>
</tr>
<tr>
<td>4.</td>
<td>Ground electrodes</td>
</tr>
<tr>
<td></td>
<td>-Material Copper clad steel</td>
</tr>
<tr>
<td></td>
<td>-Diameter ≥</td>
</tr>
<tr>
<td></td>
<td>-Length</td>
</tr>
<tr>
<td>5.</td>
<td>Material of risers</td>
</tr>
<tr>
<td>6.</td>
<td>Earthing system designed for ≤ 1</td>
</tr>
</tbody>
</table>

9.0 MAIN BUS BARS (APPLICABLE FOR ALUMINUM TUBE)

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated elsewhere in the specification. The bus bar arrangements are shown in drgs enclosed with the bid documents.

9.1 The Contractor shall furnish supporting calculations where applicable for the bus bars/conductors to show adequacy of design parameters for:

a) Fiber-stress  
b) Cantilever strength of post insulators  
c) Aeolian vibrations  
d) Vertical deflection of bus bars
e) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.

9.1.1 The welds in the aluminum tubes shall be kept to the minimum and there shall not be more than one weld per span. The procedure and details of welding shall be subject to Owner’s approval. Material for welding sleeve shall be same as that of Aluminum tube. Welding sleeve shall be of 600mm length.

9.1.2 Corona bells shall be provided wherever the bus extends beyond the clamps and on free ends, for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole in the corona bell. The material of Corona bell shall be Aluminum alloy similar to that of clamps & connectors.

9.1.3 To minimise the vibrations in the aluminium tubes, damping conductor shall be provided inside the aluminium tubes. For this purpose, the cut pieces of ACSR conductor which otherwise are considered wastages, shall be used as damping conductor.

9.1.4 Details of past experience of the persons proposed to be employed for Aluminium tube welding and the test reports of the welded pieces to prove the electrical and mechanical characteristics shall also be furnished along with the bid. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME-Section IX.

10.0 BAY EQUIPMENT

10.1 The disposition of various bay equipment shall be as per single line diagrams and layout drawings.

10.2 Bay Marshalling Kiosk:
One no. of bay marshalling kiosk shall be provided for each 220 kV and 132 kV bay under present scope. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose:-

(i) To receive two incoming 400V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum six outgoing 400V, 3 phase, 16 Amps AC supplies controlled by MCB.

(ii) To distribute minimum ten outgoing 230V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.

(iii) 200 nos. terminal blocks in vertical formation for interlocking facilities for substations without automation system.

(iv) Necessary Terminal Blocks for terminating cables from ACDB and switchyard panel rooms.

11.0 EQUIPMENT ERECTION DETAILS
11.1 For equipment interconnection, the surfaces of equipment terminal pads, Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.

11.2 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.

11.3 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

11.4 Bending of Aluminium tube and compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

11.5 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.

11.6 Handling of equipment shall be done strictly as per manufacturer's/supplier's instructions/instruction manual.

11.7 Handling equipment, sling ropes etc. should be tested periodically before erection for strength.

11.8 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

12.0 STORAGE

12.1 The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer/Owner shall be strictly adhered to.

13.0 CABLELING MATERIAL

13.1 CABLE TAGS AND MARKERS

13.1.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

13.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

13.1.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.
13.1.4 Location of underground cable joints shall be indicated with cable marker with an additional inscription “Cable joints”.

13.1.5 The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

13.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

13.2 Cable Supports and Cable Tray Mounting Arrangements

13.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

13.2.2 The supports shall be fabricated from standard structural steel members.

13.2.3 Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other places these will be at an interval of 2000 mm.

13.2.4 Vertical run of cables on equipment support structure shall be supported on perforated cable trays of suitable width which shall be suitably bolted/clamped with the equipment support structure.

13.3 Cable Termination and Connections

13.3.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Owner.

13.3.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

13.3.3 Supply of all consumable material shall be in the scope of Contractor.

13.3.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

13.3.5 Control cable cores entering control panel/switchgear/MCCB/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.

13.3.6 The Contractor shall tag/ferrule control cable cores at all terminations, as instructed by the Owner. In panels where a large number of cables are to be terminated and cable identification may be difficult, each core ferrule may include the complete cable number as well.
13.3.7 Spare cores shall be similarly tagged with cable numbers and coiled up.

13.3.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

13.3.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.

13.3.10 They shall comprise of heavy duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.

13.3.11 The cable glands shall also be suitable for dust proof and weather proof termination. The test procedure, if required, has to be discussed and agreed to between Owner and cable gland manufacturer.

13.3.12 If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor, as directed by the Owner.

13.3.13 Crimping tool used shall be of approved design and make.

13.3.14 Cable lugs shall be tinned copper solderless crimping type conforming to IS-8309 & 8394/ Equivalent International standard. Bimetallic lugs shall be used depending upon type of cables used.

13.3.15 Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

13.4 STORAGE AND HANDLING OF CABLE DRUMS

13.4.1 Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

14.0 DIRECTLY BURIED CABLES

14.1 The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers. The Bidder shall ascertain the soil conditions prevailing at site, before submitting the bid.

14.2 The cable (power and control) between LT station, control room, DG set location and fire lighting pump house shall be laid in the buried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.

14.3 Cable route and joint markers and RCC warning covers shall be provided
wherever required. The voltage grade of cables shall be engraved on the marker.

15.0 INSTALLATION OF CABLES

15.1 Cabling in the control room shall be done on ladder type cable trays for vertical runs while cabling in switchyard area shall be done on angles in the trench.

15.2 All cables from bay cable trench to equipment's including and all interpole cables (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm nominal outside diameter which shall be buried in the ground at a depth of 250mm below finish formation level. Separate PVC pipes shall be laid for control and power cables. Cable pull boxes of adequate size shall be provided if required.

15.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as recommended by the cable manufacturer shall be maintained.

15.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint.

15.5 Suitable arrangement should be used between fixed pipe / cable trays and equipment terminal boxes, where vibration is anticipated.

15.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried:

a) Power cables on top tiers.

b) Control instrumentation and other service cables in bottom tiers.

15.7 Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. All power cables shall be laid with a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables.

15.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon -6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.

15.9 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with deinterlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.

15.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:
### Table of Cable and Minimum bending radius

<table>
<thead>
<tr>
<th>Type</th>
<th>Minimum Bending Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power cable</td>
<td>12 D</td>
</tr>
<tr>
<td>Control cable</td>
<td>10 D</td>
</tr>
</tbody>
</table>

D is overall diameter of cable

15.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth.

15.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables) two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.

15.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for by the drawings, unavoidable or where permitted by the Owner. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputable make.

15.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.

15.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Owner.

15.16 Rollers shall be used at intervals of about two metres while pulling cables.

15.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.

15.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.

15.19 Inspection on receipt, unloading and handling of cables shall generally be in accordance with relevant international standard.

15.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.

15.21 Contractor shall remove the RCC/Steel trench covers before taking up the work and shall replace all the trench covers after the erection-work in that particular area is completed or when further work is not likely to be taken up for some time.

15.22 Contractor shall furnish three copies of the report on work carried out in a particular week, indicating cable numbers, date on which laid, actual length
and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.

15.23 Contractor shall paint the tray identification number on each run of trays at an interval of 10 m.

15.24 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Owner. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Owner, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

15.25 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

15.26 **Cable trays**

i) The cable trays shall be of G.S.sheet and minimum thickness of sheet shall be 2mm.

ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards.

A 2.5 metre straight section of 300mm, 600mm wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

15.27 **Conduits, Pipes and Duct Installation**

15.27.1 Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland sealing fittings, pull boxes etc as specified and to be shown in detailed drawing. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

15.27.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.

15.27.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.

15.27.4 When two lengths of conduits are joined together through a coupling, running threads equal to twice the length of coupling shall be provided on each conduit to facilitate easy dismantling of two conduits.

15.27.5 Conduit installation shall be permanently connected to earth by means of special approved type of earthing clamps. GI pull wire of adequate size shall be laid in all conduits before installation.
15.27.6 Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.

15.27.7 Embedded conduits shall have a minimum concrete cover of 50 mm.

15.27.8 Conduit run sleeves shall be provided with the bushings at each end.

15.27.9 Metallic conduit runs at termination shall have two locknuts and a bushing for connection. Flexible conduits shall also be suitably clamped at each end with the help of bushings. Bushings shall have rounded edges so as not to damage the cables.

15.27.10 Where embedded conduits turn upwards from a slab or fill, the termination dimensions shown on the drawings, if any, shall be taken to represent the position of the straight extension of the conduit external to and immediately following the bend. At least one half of the arc length of the bend shall be embedded.

15.27.11 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.

15.27.12 For underground runs, Contractor shall excavate and back fill as necessary.

15.27.13 Contractor shall supply, unload, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes, ordinary and inspection tees and elbow, checknuts, male and female bushings (brass or galvanised steel), caps, square headed male plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits.

15.27.14 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

15.27.15 Size of conduit for lighting shall be selected by the Contractor during detailed engineering.

15.27.16 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.

15.27.17 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.

15.27.18 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

15.27.19 Embedded conduits shall be securely fixed in position to preclude any
movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

15.27.20 Spacing of embedded conduits shall be such as to permit flow of concrete between them.

15.27.21 Where conduits are placed along with cable trays, they shall be clamped to supporting steel at an interval of 600mm.

15.27.22 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

15.27.23 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

15.27.24 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.

15.27.25 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

15.27.26 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

15.27.27 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

15.27.28 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

15.27.29 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations of flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

15.27.30 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

15.27.31 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

15.27.32 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

16.0 JUNCTION BOX
a) The Contractor shall supply and install junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

b) Junction boxes having volume less than 1600 cubic centimeters may be installed without any support other than that resulting from connecting conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that they are level, plumb and properly aligned to present a pleasing appearance.

c) Boxes with volumes equal to or greater than 1600 cubic cm, and smaller boxes terminating on less than two rigid metallic conduits or for other reasons not rigidly held, shall be adequately supported by auxiliary steel of standard steel shapes or plates to be fabricated and installed. The Contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment of supports.

17.0 TESTING AND COMMISSIONING

17.1 An indicative list of tests for testing and commissioning is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./instructions of the equipment Contractor or Owner without any extra cost to the Owner. The Contractor shall arrange all equipments instruments and auxiliaries required for testing and commissioning of equipments alongwith calibration certificates and shall furnish the list of instruments to the Owner for approval.

17.2 GENERAL CHECKS

(a) Check for physical damage.

(b) Visual examination of zinc coating/plating.

(c) Check from name plate that all items are as per order/specification.

(d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.

(e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.

(f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.

(g) Check cleanliness of insulator and bushings.

(h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.

(i) Check for surface finish of grading rings (Corona control ring).

(j) Pressure test on all pneumatic lines at 18.5 times the rated pressure
shall be conducted.

17.3 STATION EARTHING

a) Check soil resistivity
b) Check continuity of grid wires
c) Check earth resistance of the entire grid as well as various sections of the same.
d) Check for weld joint and application of zinc rich paint on galvanised surfaces.
e) Dip test on earth conductor prior to use.

17.4 AAC/ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS

a) Physical check for finish
b) Electrical clearance check
c) Testing of torque by torque wrenches on all bus bar power connectors and other accessories.
d) Millivolt drop test on all power connectors.
e) Sag and tension check on conductors.

17.5 ALUMINIUM TUBE WELDING

a) Physical check
b) Millivolt drop test on all joints.
c) Dye penetration test & Radiography test on 10% sample basis on weld joints.
c) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

17.6 INSULATOR

Visual examination for finish, damage, creepage distance etc.

17.7 All pre/commissioning activities and works work for substation equipment shall be carried out in accordance with owner's "Pre- Commissioning procedures and formats for substation bay equipments" by the contractor. This document shall be provided to the successful contractor during detailed engineering stage.
ANNEXURE – A

A. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 220 kV GANTRY STRUCTURE

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Max. Span</th>
<th>Conductor Configuration</th>
<th>Ph-Ph Spacing</th>
<th>Normal Tension</th>
<th>SCF per Phase</th>
<th>Spacer span</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>For Fault Level of 40 kA for 1 sec.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>54 mtr</td>
<td>QUAD ACSR</td>
<td>4.5 mtr</td>
<td>4 T</td>
<td>5.00 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>2.</td>
<td>54 mtr</td>
<td>TWIN ACSR</td>
<td>4.5 mtr</td>
<td>2 T</td>
<td>3.50 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>3.</td>
<td>74 mtr</td>
<td>TWIN ACSR</td>
<td>4.5 mtr</td>
<td>4 T</td>
<td>5.00 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>4.</td>
<td>54 mtr</td>
<td>QUAD ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.70 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>5.</td>
<td>54 mtr</td>
<td>TWIN ACSR</td>
<td>4.0 mtr</td>
<td>2 T</td>
<td>3.50 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>6.</td>
<td>74 mtr</td>
<td>TWIN ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.70 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>7.</td>
<td>48 mtr</td>
<td>QUAD ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.30 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>8.</td>
<td>52 mtr</td>
<td>QUAD ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.35 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>9.</td>
<td>68 mtr</td>
<td>TWIN ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.20 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>10.</td>
<td>56 mtr</td>
<td>QUAD ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.50 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>11.</td>
<td>72 mtr</td>
<td>TWIN ACSR</td>
<td>4.0 mtr</td>
<td>4 T</td>
<td>5.27 T</td>
<td>2.5 mtr</td>
</tr>
</tbody>
</table>

NOTE: ACSR conductor as mentioned above indicates that it is suitable for ACSR MOOSE conductor.

B. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 132 kV GANTRY STRUCTURE

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Max. Span</th>
<th>Conductor Configuration</th>
<th>Ph-Ph Spacing</th>
<th>Normal Tension</th>
<th>SCF per Phase</th>
<th>Spacer span</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>For Fault Level of 31.5kA for 1 sec.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>36 mtr</td>
<td>Twin Moose/ Zebra ACSR</td>
<td>3 mtr</td>
<td>1 T</td>
<td>2.15 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>2.</td>
<td>31.5 mtr</td>
<td>Twin Moose/ Zebra ACSR</td>
<td>2.7 mtr</td>
<td>1 T</td>
<td>2.15 T</td>
<td>2.5 mtr</td>
</tr>
<tr>
<td>3.</td>
<td>48 mtr</td>
<td>Single Moose/ Zebra ACSR</td>
<td>3 mtr</td>
<td>1 T</td>
<td>2.05 T</td>
<td>NA</td>
</tr>
<tr>
<td>4.</td>
<td>42 mtr</td>
<td>Single Moose/ Zebra ACSR</td>
<td>2.7 mtr</td>
<td>1 T</td>
<td>2.03 T</td>
<td>NA</td>
</tr>
</tbody>
</table>
ANNEXURE – B

STANDARD TECHNICAL DATA SHEETS FOR AAC/ACSR CONDUCTORS, GS EARTHWIRE AND ALUMINIUM TUBE

1.0 GENERAL

Owner has standardised the guaranteed technical particulars for the following AAC/ACSR conductors, Galvanised steel earthwire and aluminium tube. The contractor shall supply the conductors as per the standard GTP mentioned below. Any deviation to the following GTP shall be clearly brought out by the bidder in their bid.

1.1 Guaranteed Technical Particulars (GTP) for conductors:

A. GTP of ACSR MOOSE conductor:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Description</th>
<th>Unit</th>
<th>ACSR MOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Applicable Standard</td>
<td></td>
<td>IEC-61089</td>
</tr>
<tr>
<td>2.0</td>
<td>Raw Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Aluminium</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Minimum purity of Aluminium</td>
<td>%</td>
<td>99.50</td>
</tr>
<tr>
<td></td>
<td>b) Maximum copper content</td>
<td>%</td>
<td>0.04</td>
</tr>
<tr>
<td>2.2</td>
<td>Steel wires/rods</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Carbon</td>
<td>%</td>
<td>0.50 to 0.85</td>
</tr>
<tr>
<td></td>
<td>b) Manganese</td>
<td>%</td>
<td>0.50 to 1.10</td>
</tr>
<tr>
<td></td>
<td>c) Phosphorous</td>
<td>%</td>
<td>Not more than 0.035</td>
</tr>
<tr>
<td></td>
<td>d) Sulphur</td>
<td>%</td>
<td>Not more than 0.045</td>
</tr>
<tr>
<td></td>
<td>e) Silicon</td>
<td>%</td>
<td>0.10 to 0.35 (Max.)</td>
</tr>
<tr>
<td>2.3</td>
<td>Zinc</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Minimum purity of Zinc</td>
<td>%</td>
<td>99.95</td>
</tr>
<tr>
<td>3.0</td>
<td>Aluminium strands after stranding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Nominal</td>
<td>mm</td>
<td>3.53</td>
</tr>
<tr>
<td></td>
<td>b) Maximum</td>
<td>mm</td>
<td>3.55</td>
</tr>
<tr>
<td></td>
<td>c) Minimum</td>
<td>mm</td>
<td>3.51</td>
</tr>
<tr>
<td>3.2</td>
<td>Minimum Breaking load of strand</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Before stranding</td>
<td>KN</td>
<td>1.57</td>
</tr>
<tr>
<td></td>
<td>b) After stranding</td>
<td>KN</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>c) Maximum D.C. resistance of strand</td>
<td>Ohm/</td>
<td>2.921</td>
</tr>
<tr>
<td></td>
<td>at 20 deg. Centigrade</td>
<td>KM</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Maximum resistance of 1 m length of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>strand at 20 deg. C</td>
<td>Ohm</td>
<td>0.002921</td>
</tr>
<tr>
<td>4.0</td>
<td>Steel strand after stranding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sl.</td>
<td>Description</td>
<td>Unit</td>
<td>ACSR MOOSE</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>1.0</td>
<td>Applicable Standard</td>
<td></td>
<td>IEC-61089</td>
</tr>
<tr>
<td>2.0</td>
<td>Raw Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Aluminium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Nominal</td>
<td>mm</td>
<td>3.53</td>
</tr>
<tr>
<td></td>
<td>b) Maximum</td>
<td>mm</td>
<td>3.60</td>
</tr>
<tr>
<td></td>
<td>c) Minimum</td>
<td>mm</td>
<td>3.46</td>
</tr>
<tr>
<td>4.2</td>
<td>Minimum Breaking load of strand</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Before stranding</td>
<td>KN</td>
<td>12.86</td>
</tr>
<tr>
<td></td>
<td>b) After stranding</td>
<td>KN</td>
<td>12.22</td>
</tr>
<tr>
<td>4.3</td>
<td>Galvanising</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Minimum weight of zinc coating per sq.m.</td>
<td>gm</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td>b) Minimum number of dips that the galvanised strand can withstand in the standard preece test</td>
<td>Nos.</td>
<td>2 dips of one minute &amp; 1 dip of half minute</td>
</tr>
<tr>
<td></td>
<td>c) Min. No. of twists in gauge length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)</td>
<td>Nos.</td>
<td>16 (After stranding) 18 (Before stranding)</td>
</tr>
<tr>
<td>5.0</td>
<td>ACSR Conductor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>a) Stranding</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Number of Strands</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Steel centre</td>
<td>Nos.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ii. 1st Steel Layer</td>
<td>Nos.</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>iii. 1st Aluminium Layer</td>
<td>Nos.</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>iv. 2nd Aluminium Layer</td>
<td>Nos.</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>v. 3rd Aluminium Layer</td>
<td>Nos.</td>
<td>24</td>
</tr>
<tr>
<td>5.2</td>
<td>Sectional Area of aluminium</td>
<td>Sq. mm</td>
<td>528.50</td>
</tr>
<tr>
<td>5.3</td>
<td>Total sectional area</td>
<td>Sq. mm</td>
<td>597.00</td>
</tr>
<tr>
<td>5.4</td>
<td>Approximate Weight</td>
<td>Kg/m</td>
<td>2.004</td>
</tr>
<tr>
<td>5.5</td>
<td>Diameter of the conductor</td>
<td>mm</td>
<td>31.77</td>
</tr>
<tr>
<td>5.6</td>
<td>UTS of the conductor</td>
<td>kN</td>
<td>161.20 (Min.)</td>
</tr>
<tr>
<td>5.7</td>
<td>Lay ratio of the conductor</td>
<td>mm</td>
<td>Max    Min</td>
</tr>
<tr>
<td></td>
<td>a) Outer Steel layer</td>
<td>mm</td>
<td>18      16</td>
</tr>
<tr>
<td></td>
<td>b) 8/12 wire Aluminium layer</td>
<td>mm</td>
<td>14      12</td>
</tr>
<tr>
<td></td>
<td>c) 14/18 wire Aluminium layer</td>
<td>mm</td>
<td>13      11</td>
</tr>
<tr>
<td>Sl.</td>
<td>Description</td>
<td>Unit</td>
<td>ACSR MOOSE</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>1.0</td>
<td>Applicable Standard</td>
<td>IEC-61089</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Raw Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Aluminium</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) 20/24 wire Aluminium layer</td>
<td>mm</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2.8 DC resistance of the conductor at 20°C</td>
<td>ohm/km</td>
<td>0.05552</td>
</tr>
<tr>
<td>5.9</td>
<td>Standard length of the conductor</td>
<td>m</td>
<td>1800</td>
</tr>
<tr>
<td>5.10</td>
<td>Tolerance on Standard length</td>
<td>%</td>
<td>(+/-) 5</td>
</tr>
<tr>
<td>5.11</td>
<td>Direction of lay of outer layer</td>
<td>-</td>
<td>Right Hand</td>
</tr>
<tr>
<td>5.12</td>
<td>Linear mass of the conductor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Standard</td>
<td>kg/km</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td>b) Minimum</td>
<td>kg/km</td>
<td>1965</td>
</tr>
<tr>
<td></td>
<td>c) Maximum</td>
<td>kg/km</td>
<td>2045</td>
</tr>
<tr>
<td>5.13</td>
<td>Modulus of Elasticity (Final State)</td>
<td>Kg/sq.mm</td>
<td>6860</td>
</tr>
<tr>
<td>5.14</td>
<td>Co-efficient of Linear Expansion</td>
<td>Per Deg. C</td>
<td>19.3x10^-6</td>
</tr>
<tr>
<td>5.15</td>
<td>Minimum Corona Extinction Voltage</td>
<td>KV (rms)</td>
<td>320</td>
</tr>
<tr>
<td>5.16</td>
<td>RIV at 1 Mhz under dry condition</td>
<td>Microvolts</td>
<td>Max. 1000 at 320 kV (rms)</td>
</tr>
<tr>
<td>6.0</td>
<td>Drum Dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Flange Diameter</td>
<td>mm</td>
<td>1800</td>
</tr>
<tr>
<td></td>
<td>b) Traverse width</td>
<td>mm</td>
<td>950</td>
</tr>
<tr>
<td></td>
<td>c) Barrel Diameter</td>
<td>mm</td>
<td>650</td>
</tr>
<tr>
<td></td>
<td>d) Flange thickness</td>
<td>mm</td>
<td>50x50</td>
</tr>
</tbody>
</table>

1.2 Guaranteed technical particulars of Galvanised Steel Earthwire

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Standard Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Raw Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Steel wires / rods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Carbon</td>
<td>%</td>
<td>Not more than 0.55</td>
</tr>
<tr>
<td>b) Manganese</td>
<td>%</td>
<td>0.40 to 0.90</td>
</tr>
<tr>
<td>c) Phosphorous</td>
<td>%</td>
<td>Not more than 0.04</td>
</tr>
<tr>
<td>d) Sulphur</td>
<td>%</td>
<td>Not more than 0.04</td>
</tr>
<tr>
<td>e) Silicon</td>
<td>%</td>
<td>0.15 to 0.35</td>
</tr>
<tr>
<td>1.2 Zinc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Minimum purity of Zinc</td>
<td>%</td>
<td>99.95</td>
</tr>
</tbody>
</table>
## 2.0 Steel strands

### 2.1 Diameter

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Nominal</td>
<td></td>
<td>3.66</td>
</tr>
<tr>
<td>b) Maximum</td>
<td></td>
<td>3.74</td>
</tr>
<tr>
<td>c) Minimum</td>
<td></td>
<td>3.58</td>
</tr>
</tbody>
</table>

### 2.2 Minimum breaking load of strand

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) After stranding</td>
<td>KN 10.58</td>
</tr>
</tbody>
</table>

### 2.3 Galvanising

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>gms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Minimum weight of zinc coating per sq.m. after stranding</td>
<td></td>
<td>275</td>
</tr>
<tr>
<td>b) Minimum number of dips that the galvanized strand can withstand in the standard preece test</td>
<td>Nos.</td>
<td>3 dips of 1 minute and one dip of ½ minute</td>
</tr>
<tr>
<td>c) Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding</td>
<td>Nos.</td>
<td>18</td>
</tr>
</tbody>
</table>

## 3.0 Stranded Earth wire

### 3.1 UTS of Earth wire

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>KN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>68.4 (min.)</td>
</tr>
</tbody>
</table>

### 3.2 Lay length of outer steel layer

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Standard</td>
<td></td>
<td>181</td>
</tr>
<tr>
<td>b) Maximum</td>
<td></td>
<td>198</td>
</tr>
<tr>
<td>c) Minimum</td>
<td></td>
<td>165</td>
</tr>
</tbody>
</table>

### 3.3 Maximum DC resistance of earth wire at 20°C

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Ohm/km</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3.375</td>
</tr>
</tbody>
</table>

### 3.4 Standard length of earth wire

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2000 or actual quantity whichever is less.</td>
</tr>
</tbody>
</table>

### 3.5 Tolerance on standard length

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>±5</td>
</tr>
</tbody>
</table>

### 3.6 Direction of lay for outside layer

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right hand</td>
</tr>
</tbody>
</table>

### 3.7 Linear mass

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Kg/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Standard</td>
<td></td>
<td>583</td>
</tr>
<tr>
<td>b) Maximum</td>
<td></td>
<td>552</td>
</tr>
<tr>
<td>c) Minimum</td>
<td></td>
<td>600</td>
</tr>
</tbody>
</table>

### 3.8 Overall diameter

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm 10.98</td>
</tr>
</tbody>
</table>

### 1.3 Guaranteed Technical Parameters of Aluminum Tube

**A. GTP for 3” IPS & 4” IPS AL. TUBE**
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>3” AL. TUBE</th>
<th>4” AL. TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Size</td>
<td>3” IPS (EH Type)</td>
<td>4” IPS (EH Type)</td>
</tr>
<tr>
<td>2.</td>
<td>Material</td>
<td>Aluminium Alloy 6101 T6 confirms to 63401 WP (range 2) of IS 5082 : 1998/Equivqlent BS standard</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Chemical Composition</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Cu</td>
<td>0.05 Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) Mg</td>
<td>0.4 to 0.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii) Si</td>
<td>0.3 to 0.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iv) Fe</td>
<td>0.5 Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>v) Mn</td>
<td>0.03 Max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vi) Al</td>
<td>Remainder</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Outer diameter</td>
<td>88.90 mm</td>
<td>114.2 mm</td>
</tr>
<tr>
<td>5.</td>
<td>Tolerance on outer diameter</td>
<td>+2.2 mm, - 0.0 mm</td>
<td>+2.2 mm, - 0.0 mm</td>
</tr>
<tr>
<td>6.</td>
<td>Thickness</td>
<td>7.62 mm</td>
<td>8.51 mm</td>
</tr>
<tr>
<td>7.</td>
<td>Tolerance on thickness</td>
<td>+2.2 mm, - 0.0 mm</td>
<td>+2.2 mm, - 0.0 mm</td>
</tr>
<tr>
<td>8.</td>
<td>Cross-sectional area</td>
<td>1945.76 sq.mm</td>
<td>2825.61 sq.mm</td>
</tr>
<tr>
<td>9.</td>
<td>Weight</td>
<td>5.25 kg/m</td>
<td>7.7 kg/m</td>
</tr>
<tr>
<td>10.</td>
<td>Moment of Inertia</td>
<td>1621589.99 mm²</td>
<td>3972577.97 mm²</td>
</tr>
<tr>
<td>11.</td>
<td>Section Modulus</td>
<td>36481.21 mm³</td>
<td>69572.29 mm³</td>
</tr>
<tr>
<td>12.</td>
<td>Minimum Ultimate Tensile Strength</td>
<td>20.5 Kg/sq.mm</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Temperature co-efficient of resistance</td>
<td>0.00364 per Deg.C</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Minimum Electrical Conductivity at 20 deg.C</td>
<td>55% of IACS</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Linear Temperature Co-efficient of Expansion (20 Deg.C - 200 Deg.C)</td>
<td>0.000023</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Modulus of Elasticity</td>
<td>6700 Kg/sq.mm</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Minimum Elongation on 50 mm</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Thermal Conductivity at 100 Deg.C</td>
<td>0.43 Calories/sec/sq.mm/cm/deg.C</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Minimum 0.2% proof stress</td>
<td>17.34 Kg/sq.mm</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Minimum Yield point</td>
<td>17.50 Kg/sq.mm</td>
<td>17.50 Kg/sq.mm</td>
</tr>
<tr>
<td>21.</td>
<td>Minimum Breaking Strength</td>
<td>20.42 Kg/sq.mm</td>
<td>20.42 Kg/sq.mm</td>
</tr>
</tbody>
</table>
ANNEXURE – C

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all 220kV & 132kV equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

2. Test Levels:

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

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part - 1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

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

3.3 In measurement of RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100% and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure
shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser’s inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser’s inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

a) Background noise before and after test.

b) Detailed procedure of application of test voltage.

c) Measurements of RIV levels expressed in micro volts at each level.

d) Results and observations with regard to location and type of interference sources detected at each step.

e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.

f) Onset and extinction of visual corona for each of the four tests required shall be recorded.
# CHAPTER 13 - STRUCTURE

## CONTENTS

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>General</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>Design Requirements For Structures</td>
<td>2</td>
</tr>
<tr>
<td>3.0</td>
<td>Design, Drawings, Bill Of Materials And Documents</td>
<td>4</td>
</tr>
<tr>
<td>4.0</td>
<td>Fabrication And Erection</td>
<td>4</td>
</tr>
<tr>
<td>5.0</td>
<td>Bolting</td>
<td>5</td>
</tr>
<tr>
<td>6.0</td>
<td>Welding</td>
<td>5</td>
</tr>
<tr>
<td>7.0</td>
<td>Foundation Bolts</td>
<td>5</td>
</tr>
<tr>
<td>8.0</td>
<td>Stability Of Structure</td>
<td>6</td>
</tr>
<tr>
<td>9.0</td>
<td>Grouting</td>
<td>6</td>
</tr>
<tr>
<td>10.0</td>
<td>Galvanising</td>
<td>6</td>
</tr>
<tr>
<td>11.0</td>
<td>Touch-Up Painting</td>
<td>6</td>
</tr>
<tr>
<td>12.0</td>
<td>Inspection Before Dispatch</td>
<td>7</td>
</tr>
<tr>
<td>13.0</td>
<td>Test Certificate</td>
<td>7</td>
</tr>
<tr>
<td>14.0</td>
<td>Mode Of Measurement</td>
<td>7</td>
</tr>
<tr>
<td>15.0</td>
<td>Safety Precautions</td>
<td>7</td>
</tr>
<tr>
<td>16.0</td>
<td>Manufacturing Quality Plan</td>
<td>7</td>
</tr>
</tbody>
</table>
1.0 GENERAL

The scope of specification covers design, fabrication, trial assembly, supply and erection of galvanized steel structures for towers, girders, lightning masts and equipment support structures. Structures shall be lattice or Pipe type structure fabricated from structural steel conforming to relevant British standard Codes (BS Codes)/ equivalent International Standards.

Line diagrams of Towers, girders, Lightning mast, equipment support structures for 220kV structures enclosed with the tender document are for information only. However, The line diagram of all structures of 220 kV, 132kV and 33 kV for new switch yards shall be prepared by the contractor based on their design during detailed engineering stage. The fabrication drawing/line diagram of structures for extension of existing switch yards shall be furnished by NEA/Consultant to the successful bidder progressively during detailed engineering stage. The bidder shall mention in their bid for the type of proposed structure i.e. Pipe or lattice type structure. The fabrication drawings, proto corrected drawings along with Bill of Material (BOM) for all the structures (Both Gantry and Equipment support structures) shall be prepared by the contractor during detailed engineering for submission to NEA/Consultant for their approval. Support structure for circuit breaker shall also be designed by the Manufacturer/Contractor.

It is the intent of the NEA/Consultant to provide structures which allow interchangeability of equipment at a later stage. Accordingly, Contractor is expected to design the equipment support structures with the provision of stool. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, ground mounted marshalling boxes (AC/DC Marshalling box & equipment control cabinets), structure mounted marshalling boxes and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures and anchor/foundation bolts, fasteners (Nuts, bolts, and washers) shall be fully galvanized as per relevant British standard Codes (BS Codes) / equivalent International Standards. The weight of the zinc coating shall be at least 610 grams /sq. m for anchor bolts/foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

Contractor shall provide suitable arrangement on the equipment support structures wherever required to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box, surge counter, etc. in the equipment structure fabrication drawings.
2.0 DESIGN REQUIREMENTS FOR STRUCTURES

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on relevant British standard Codes (BS Codes) / equivalent International Standards.

2.2 For materials and permissible stresses, relevant British standard Codes (BS Codes) / equivalent International Standards. Shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

2.3 Minimum thickness of galvanized lattice structure member shall be as follows:

<table>
<thead>
<tr>
<th>Members</th>
<th>Min Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg members, Ground wire</td>
<td>5</td>
</tr>
<tr>
<td>Peak members/Main members</td>
<td>5</td>
</tr>
<tr>
<td>Other members</td>
<td>4</td>
</tr>
<tr>
<td>Redundant members</td>
<td>4</td>
</tr>
</tbody>
</table>

2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per relevant British standard Codes (BS Codes) / equivalent International Standards.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 All bolts shall be M16 or higher as per design requirement.

2.7 **Step Bolts**

In order to facilitate inspection and maintenance, the tower structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on diagonally opposite legs extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to relevant British standard Codes (BS Codes) / equivalent International Standards. Ladders along with safety guard shall be provided for the Lightning Mast Tower.

2.8 **Design Criteria**

a) All gantry structures shall be designed for the worst combination of dead loads, live loads, wind loads and Seismic forces as per relevant British standard Codes (BS Codes) / equivalent International Standards. (latest), loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including “snatch” in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40.0 kA for 220kV, 31.5KA for 132kV and 25KA for 33kV or as applicable. Relevant British standard Codes (BS Codes) / equivalent International Standards. May be followed for evaluation of short circuit forces.

b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures
shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads for the design of switchyard structures.

c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 2 metric tons per phase for 220 kV, 1 Metric tons per phase for 132 kV and 0.50 Metric Ton for 33 kV or as per requirements whichever is higher. The distance between terminal gantry and dead end tower shall be taken as 200 meters for 220kV, 150m for 132kV and 80 m for 33 kV switch yard. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

e) The girders/beams shall be connected with lattice/Tower columns by bolted joints.

f) All equipment support structures shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per relevant British standard Codes (BS Codes) / equivalent International Standards.

g) If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.

h) Foundation bolts shall be designed for the loads for which the structures are designed.

i) The height of Lightning Mast shall be as per approved structural layout and designed for diagonal wind condition. The lightning mast shall be provided with platform for mounting of lighting fixtures and a structural steel ladder within its base up to the level of platform. The ladder shall be provided with protection rings The platforms shall also have protection railing. The details of lighting fixtures would be as per approved drawings of electrical fixtures.
3.0 DESIGN, DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

3.1 The Contractor shall submit design and line diagram of each structure for approval of NEA/Consultant. Fabrication drawing based on approved line diagram shall be prepared by the contractor for approval of NEA/Consultant. The BOM (Bill Of Material) shall be prepared by the contractor based on approved fabrication drawing. The Line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints. In case NEA/Consultant feels that any design or drawings are to be modified even after its approval, Contractor shall modify the designs & drawings and resubmit the same for approval.

3.2 The fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice. The fabrication drawing and bill of material based on design/line diagram shall be submitted to NEA/Consultant for approval. Approved bill of materials prepared on the basis of fabrication drawing shall be the basis for payment.

3.3 Such approvals shall, however, not relieve the contractor of his responsibility for safety and durability of the structure and good connection and any loss occurring due to defective fabrication, design or workmanship shall be borne by the contractor.

3.4 The contractor shall submit editable soft copy of all designs preferably in Staad / excel form and drawings in AutoCAD to NEA/Consultant. The list of British standard codes relevant to steel structures have been given in Chapter-14-Civil section of technical specification This list is illustrative but not exhaustive. The contractor shall submit the copy of relevant portion of BS codes/equivalent International standard referred to NEA/Consultant for reference if necessary during detailed engineering stage.

4.0 FABRICATION AND ERECTION

4.1 The fabrication and erection works shall be carried out generally in accordance with relevant British standard Codes (BS Codes) / equivalent International Standards. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.
4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

4.3 Sample towers, beams and lightning masts and equipment support structures may be trial assembled in the fabrication shop to ensure fitment of various members and to avoid problems during erection.

4.4 For all structures, BOM along with fabrication drawings in hard and editable soft copies shall be submitted to NEA/Consultant as document for information. The responsibility of correctness of such fabrication drawing and BOM shall be fully with the contractor.

4.5 Approval of fabrication drawings and BOM shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

4.6 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipment and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification if any, required during erection shall be done at site with the approval of NEA/Consultant.

5.0 BOLTING

i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

ii) In case of fasteners, the galvanizing shall confirm to relevant British standard Codes (BS Codes) / equivalent International Standards. The spring washer shall be electro galvanized as per relevant British standard Codes (BS Codes) / equivalent International Standards.

6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld. Symbols for welding on erection and shop drawings shall be according to relevant British standard Codes (BS Codes) / equivalent International Standards. Welding shall be carried out in accordance to relevant British standard Codes (BS Codes) / equivalent International Standards.

7.0 FOUNDATION BOLTS

7.1 Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel
work on site to ensure that the towers/structures are plumb.

7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

7.4 All foundation bolts shall be fully galvanized so as to achieve minimum 610 grams Per Sq. m of Zinc Coating as per relevant British standard Codes (BS Codes) / equivalent International Standards.

7.5 All foundation bolts and its material shall conform to relevant British standard Codes (BS Codes) / equivalent International Standards. All foundation bolts shall be provided with two number standard nuts, one check nut, one plain washer and MS plate at the bottom of foundation bolt.

8.0 STABILITY OF STRUCTURE
The Supplier shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

9.0 GROUTING
The method of grouting the column bases shall be subject to approval of NEA/Consultant and shall be such as to ensure a complete uniformity of contract over the whole area of the steel base. No additional payment for grouting shall be admissible.

10.0 GALVANISING

10.1 All structural steel works (Gantry structures, Equipment support structures) and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement relevant British standard Codes (BS Codes) / equivalent International Standards.

10.2 Zinc required for galvanizing shall have to be arranged by the Contractor/manufacturer. Purity of zinc to be used shall be 99.95% as per relevant British standard Codes (BS Codes) / equivalent International Standards.

10.3 The Contractor shall be required to make arrangement for frequent inspection by the owner as well as continuous inspection by a resident representative of the owner, if so desired for fabrication work.

11.0 TOUCH-UP PAINTING
Minor defects in hot dip galvanized members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of NEA/Consultant before erection.
12.0 INSPECTION BEFORE DISPATCH
Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by NEA/Consultant or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

13.0 TEST CERTIFICATE
Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted to NEA/Consultant.

14.0 MODE OF MEASUREMENT
The measurement of the structure, fasteners (Nuts, Bolts and Washers) and foundation bolts including its nuts washers and MS Plate at the bottom shall be done as per the Bid Price schedule (BPS). The weight of all structure members and foundation bolts (Bolts, washer and MS steel plates welded at the bottom of bolt) shall be measured under one head Metric Ton. The weight of fasteners and step bolts (Nuts, Bolts and washers) used to erect/complete structures shall be measured under another head in Metric Tons.

15.0 SAFETY PRECAUTIONS
The Contractor shall strictly follow all precautions at all stages of fabrication, transportation and erection of steel structures. The stipulations contained in relevant British standard Codes (BS Codes) / equivalent International Standards for Safety during erection of structural steel work shall also be adhered to.

16.0 MANUFACTURING QUALITY PLAN
The material specification shall also be as per relevant British standard Codes (BS Codes) / equivalent International Standards. The Contractor shall prepare the manufacturing quality plan to accept/check the material, galvanization and welding as per relevant international standards/BS codes within 1 month after award of work and submit the same to NEA/Consultant for approval.
# CHAPTER 14: CIVIL WORKS

## CONTENTS

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GENERAL</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>GEOTECHNICAL INVESTIGATION</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>CONTOUR SURVEY, SITE LEVELLING</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>SITE PREPARATION, EXCAVATION, BACKFILL &amp; DISPOSAL OF SURPLUS EARTH.</td>
<td>7</td>
</tr>
<tr>
<td>5.</td>
<td>ANTIWEED TREATMENT &amp; STONE SPREADING</td>
<td>9</td>
</tr>
<tr>
<td>6.</td>
<td>SITE DRAINAGE</td>
<td>11</td>
</tr>
<tr>
<td>7.</td>
<td>ROADS</td>
<td>13</td>
</tr>
<tr>
<td>8.</td>
<td>TRANSFORMERS/REACTOR FOUNDATION, RAIL TRACK/ RAIL CUM ROAD TRACK</td>
<td>13</td>
</tr>
<tr>
<td>9.</td>
<td>FIRE PROTECTION WALLS</td>
<td>14</td>
</tr>
<tr>
<td>11.</td>
<td>FOUNDATION / RCC CONSTRUCTION</td>
<td>16</td>
</tr>
<tr>
<td>12.</td>
<td>CHAINLINK FENCING AND GATE</td>
<td>19</td>
</tr>
<tr>
<td>13.</td>
<td>BUILDINGS</td>
<td>21</td>
</tr>
<tr>
<td>14.</td>
<td>FIRE FIGHTING PUMP HOUSE BUILDING</td>
<td>30</td>
</tr>
<tr>
<td>15.</td>
<td>AUXILLIARY BUILDING</td>
<td>34</td>
</tr>
<tr>
<td>16.</td>
<td>FIRE FIGHTING WATER TANK</td>
<td>35</td>
</tr>
<tr>
<td>17.</td>
<td>SWITCH YARD PANEL ROOM</td>
<td>35</td>
</tr>
<tr>
<td>18.</td>
<td>CAR PARKING SHED</td>
<td>36</td>
</tr>
<tr>
<td>19.</td>
<td>WATER SUPPLY</td>
<td>36</td>
</tr>
<tr>
<td>20.</td>
<td>SEWERAGE SYSTEM</td>
<td>36</td>
</tr>
<tr>
<td>21.</td>
<td>GIS HALL CUM CONTROL ROOM BUILDING</td>
<td>37</td>
</tr>
</tbody>
</table>
22. RESIDENTIAL AND NON RESIDENTIAL BUILDINGS ......................................................... 46
23. COMMUNITY HALL AND GYM HALL .................................................................. 53
24. STORE BUILDING ........................................................................................................ 58
25. BOUNDARY WALL, MAIN GATE, SECURITY ROOM AND SEPTIC TANK AND SOAK PIT... 61
26. MODE OF MEASUREMENT .......................................................................................... 62
27. MISCELLANEOUS GENERAL REQUIREMENTS ............................................................ 67
28. INTERFACING ................................................................................................................. 69
29. STATUTORY RULES ....................................................................................................... 69
30. FIELD QUALITY PLAN ................................................................................................. 69
31. BRITISH STANDARD CODES ...................................................................................... 69
1. GENERAL

The intent of specification covers the following:

Design, engineering, drawing and construction of all civil works at sub-station. All civil works shall also satisfy the general technical requirements specified in other Sections of Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification or implied as per relevant British standard codes (BS Codes)/ equivalent International Standards.

All civil works shall be carried out as per applicable Standards and Codes. All materials shall be of best quality conforming to relevant International Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the provisions of Technical Specification shall prevail.

The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and direction of NEA/Consultant.

The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the NEA/Consultant. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

2. GEOTECHNICAL INVESTIGATION

2.1 The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate, general as well as specific information about the soil profile and the necessary soil parameters of the Site in order that the foundation of the various structures can be designed and constructed safely and rationally.

A detailed soil report including field data duly certified by site engineers of NEA/Consultant will be submitted by the Contractor for specific approval of NEA/Consultant. The report shall contain all soil parameters along with recommendation of soil consultant for type of foundation i.e. pile or open type, soil treatment if any etc. to be used for the design of civil foundations.

2.2 The Contractor may visit the site to ascertain the soil parameters. Any variation in soil data shall not constitute a valid reason for any additional cost & shall not affect the terms & conditions of the contract. Field tests must be conducted covering entire substation area including all the critical locations i.e. Control Room and GIS Building, township buildings, Lightning Mast. Towers, transformer/Reactor etc.

2.3 SCOPE OF WORK

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilisation of necessary equipment, providing necessary engineering supervision and technical personnel,
skilled and unskilled labour etc. as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata for the various structures of the substation. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the NEA/Consultant. The soil investigation for substation extension in existing switch yard has not been envisaged. Soil data of existing substation shall be referred for the design of foundations in switch yard extension under present scope of work.

All the work shall be carried out as per latest edition of the corresponding relevant British standard codes (B S Codes)/ equivalent International Standards. The Agency carrying out the soil investigation work must have the experience of carrying out soil investigation successfully in the relevant field. NEA shall assess the capability of the agency for soil investigation work for which technical inputs may be furnished by consultant to NEA.

2.3.1 **BORE HOLES**

Bore holes of Minimum 150 mm diameter in accordance with the provisions of relevant international standards/British standards(BS) at the rate of minimum one number bore hole per hectare up to 25 meter depth (Minimum) or to refusal which ever occur earlier shall be drilled for new areas (220 kV Yards and 220/132/33 kV yards wherever applicable). In any case number of boreholes shall not be less than five. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. Number of boreholes may be increased in case soil strata are varying from borehole to borehole in order to have fair idea of soil profile. In case of deep pile foundations soil investigation is to be carried out up to 30 m depth from ground level or refusal whichever is earlier. In case rock is encountered, coring in all the boreholes shall be carried out up to 3 meter in rock.

Performing Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 1.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests. Standard Penetration Test shall be performed as per relevant British standard codes (B S Codes)/ equivalent International Standards.

Undisturbed samples shall be collected in accordance with the recommendation of relevant British standard codes (B S Codes)/ equivalent International Standards. Or an alternative recognize method as agreed by NEA/Consultant. Undisturbed samples shall be taken in cohesive material or weak cemented granular material where ever possible at 1.0 m interval or at each change in stratum.

The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the water table for rainy season shall be collected from reliable sources and recorded in the report.

All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.

The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the Contractor’s laboratory without any damage or loss.
The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-change.

2.3.2 TRIAL PITS

The Contractor shall excavate two number trial pits per substation (New) as and where directed by NEA/Consultant, of Plan area 10 sq.m. and not exceeding 4 m depth. Undisturbed samples shall be taken from the trial pits as per the direction of the NEA/Consultant. All Trial Pits shall be re-filled with approved material after the tests are complete and shall be compacted in layers of not more than 500mm.

2.3.3 ELECTRICAL RESISTIVITY TEST

This test shall be conducted to determine the Electrical resistivity of soil required for designing safety-grounding system for the entire station area. The specifications for the equipments and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to relevant British standard codes (B S Codes)/ equivalent International Standards. The test shall be conducted using Wagner’s four electrode method as specified in relevant British standard codes (B S Codes)/ equivalent International Standards. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the coordinate axis. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.2 m up to a distance of 50.0 m.

2.3.4 PLATE LOAD TEST

Two number of Plate load tests shall be conducted each at the location of control room / GIS building and township area as applicable only to determine the bearing capacity, modulus of sub grade reaction and load/settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs. The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to relevant BS standard. Plate load test shall be performed at the proposed foundation depth below finished ground level for bearing capacity.

Undisturbed tube samples shall also be collected from the pit at 1.0 m depth and bottom of pit from natural ground level for carrying out laboratory tests.

The size of the pit in plate load test shall not be less than five times the plate size and shall be taken up to the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate.

The load shall be increased in stages. Under each loading stage, record of Time vs. Settlement shall be kept as specified in relevant British standard codes (B S Codes)/ equivalent International Standards.

Backfilling of the pit shall be carried out as per the directions of the NEA/Consultant. Unless otherwise specified the excavated soil shall be used for this purpose. In
cases of gravel-boulder or rocky strata, respective relevant codes shall be followed for tests.

2.3.5 WATER SAMPLE

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air-tight containers.

2.3.6 BACK FILLING OF BORE HOLES

On completion of each hole, the Contractor shall backfill all bore holes as directed by the NEA/Consultant. The backfill material can be the excavated material.

2.3.7 LABORATORY TEST

1. The laboratory tests shall be carried out progressively during the field work after sufficient number of samples has reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.

2. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid out in the relevant British standard codes (B S Codes)/ equivalent International Standards.

The following laboratory tests shall be carried out

a) Visual and Engineering Classification

b) Atterberg limits Tests.

c) Natural moisture content, bulk density and specific gravity.

d) Grain size distribution analysis.

e) Swell pressure and free swell index determination.

f) California bearing ratio.

g) Consolidated drained test with pore pressure measurement.

h) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.

i) In case rock is encountered, the soil test required for rock as per relevant British standard codes (B S Codes)/ equivalent International Standards including following tests shall also be conducted.
   • UCC test.
   • Point load index test.
2.3.8 **TEST RESULTS AND REPORTS**

The Contractor shall submit the detailed report in two (2) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. The contractor shall also submit the bearing capacity calculation in editable soft copy to NEA/consultant. Initially the contractor shall submit draft report and after the draft report is approved, the final report in four (4) copies shall be submitted. The field and laboratory test data shall bear the signatures of the Investigation Agency, Contractor and also site representative of NEA/Consultant.

The report shall include, but not limited to the following:

a) A plan showing the locations of the exploration work i.e. bore holes, trial pits. Plate load test, electrical resistivity test, CBR sample location etc.

b) Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.

Test results of field and laboratory tests shall be summarised strata wise as well in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.

**Recommendations:** The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the NEA/Consultant. The observations and recommendations shall include but not limited to the following:

a) Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.

b) Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.

c) Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 3.0 (three). Recommendation of liquefaction characteristics of soil if applicable shall be provided.

d) Recommendations regarding slope of excavations and dewatering schemes, if required.

e) Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
f) If expansive soil is met with, recommendations on removal or retainment of the same under the structure, road, drains, etc. and thickness of treatment shall be given. In the latter case detailed specification of any special treatment required including specification or materials to be used, construction method, equipments to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.

g) Recommendations for additional investigations beyond the scope of the present work, if considered such investigation as necessary.

f) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given.

3. CONTOUR SURVEY, SITE LEVELLING

3.1 CONTOUR SURVEY & SITE LEVELLING:
The land for construction of substation will be handed over to the successful bidder as on where basis progressively after award of work. The contractor shall carry out survey work by taking spot level at 05 m x 05 m grid interval with respect to temporary bench mark transferred from permanent bench mark in the locality if available either on bridge, government buildings of local authorities or any other permanent structure. The contractor shall submit the spot levels (in grid format) in editable soft copy in excel format and contour map with contour interval of 0.5 m in editable auto cad soft drawing.

The contractor will level the area required for construction of substation work either at single level, multi-level or gradual slope with the finished ground level as approved by NEA/Consultant during detailed engineering based on highest flood level. The levelling area shall be decided by NEA/Consultant during detailed Engineering stage.

The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by NEA/Consultant. The Contractor shall provide all assistance in instruments, materials and personnel to NEA/Consultant for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

3.2 SCOPE

This covers clearance of site, contour survey, site levelling, maintaining finished ground level by cutting/filling in all types of soil and soft/ disintegrated rock, supplying and compaction of fill material if required. Cutting/felling of trees and their disposal has not been envisaged under the present scope.

3.3 GENERAL

Site shall be cleared, surveyed and levelled/sloped by the contractor as per approved general arrangement drawing or levelling area decided during detailed engineering after award of work.

Work covered under this clause comprises the site clearance, survey work/setting out and making profiles (preparation of plot plan, setting up Bench Mark and taking
spot levels at 05m x 05 m interval, preparation of contour plan with contour interval of 0.50 m), Earth work in Excavation & filling in specified area with all lifts and leads and earth work in filling with borrowed earth with all leads and lifts (Borrow areas including payment of royalty for borrowed earth shall be arranged by the contractor at his own cost). During detailed engineering stage, the contractor will prepare the levelling proposal for optimum levelling and submit to NEA/Consultant for approval. Contractor shall submit the hard copy and editable soft copy of levelling proposal (levelling quantity calculation in Excel form and levelling drawing in Auto CAD) to NEA/Consultant for approval.

3.4 Filling material shall conform to relevant British standard codes (BS Codes)/equivalent International Standards. Unsuitable filling material if any shall be removed and replaced by suitable fill material. The filling shall be compacted in layers to achieve 95% of standard Proctor’s density at Optimum moisture contents (OMC). Cohesion less material shall be compacted to 70% relative density (minimum). Levelling/Filling shall be carried out as per relevant British standard codes (B S Codes)/equivalent International Standards.

3.5 All materials involved in excavation shall be classified by NEA/Consultant in the following groups:

3.5.1 All kinds of soils and soft/disintegrated rocks (Not requiring blasting): The material which can be quarried/excavated with pick, shovel, jumpers, scarifiers, crowbars and mechanical implements and will include various types of soils, plain cement concrete, shingle, river/nallah boulders, soling of road/foot path, stone masonry, soft conglomerate and laterite stone, lime stone and hard conglomerate etc.

3.5.2 Hard Rocks: All kinds of rocks which can only be excavated by machines and requires blasting, chiselling in edging or in another agreed method and will also include reinforcement cement concrete.

3.6 The quantity of excavation in all types of soils and soft/disintegrated rock shall be worked out by using initial and final level and no void deduction shall be made to calculate net quantity of earth work with 95% compaction.

3.7 The volume of hard rock shall be computed on the basis of stack of excavated rubble after making 50 % deduction for voids.

3.8 The surface of excavation or filling shall be neatly dressed to the required formation level with tolerance of (+) 100 mm.

4. SITE PREPERATION, EXCAVATION, BACKFILL & DISPOSAL OF SURPLUS EARTH.

4.1 SITE PREPERATION

The layout and levels of all structure etc shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the NEA/Consultant. The Contractor shall give all help in instruments, materials and personnel to the NEA/Consultant for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

4.2 SCOPE

This clause covers clearing of the site, maintaining the finished ground level with available surplus excavated suitable back fill material generated from foundation works etc.
4.3 GENERAL

1) The Contractor shall develop the site area to meet the requirement of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of relevant British standard codes (B S Codes)/ equivalent International Standards.

2) The fill material shall be suitable for the above requirement. The fill shall be with such a material that the site so designed shall not be affected by erosion from wind and water from its final compacted position or the in-situ position of undisturbed soil.

3) Material unsuitable for founding of foundations shall be removed and replaced by suitable fill material to be approved by the NEA/Consultant.

4) Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by purchaser up to a maximum lead of 2 km.

4.4 EXCAVATION AND BACKFILL

SCOPE

This clause covers excavation for foundation works of Towers, Equipment support structures, Transformer/Reactor foundations, External Lighting poles, Cable trenches, Buildings, Car parking shed, Fire Wall, DG set, Water tanks, etc, backfilling of Foundations Works.

1. Excavation and backfill for foundations shall be in accordance with the relevant British standard codes (B S Codes)/ equivalent International Standards.

2. Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

3. When embankments are to be constructed on slopes of 15\% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.

4. Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness. (Of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Purchaser. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.

5. Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width...
specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

4.5 COMPACTION

1. The density to which fill materials shall be compacted shall be as per relevant BS and as per direction of NEA/Consultant. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor’s density at OMC. The sub grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor’s density at OMC. Cohesion less material sub grade shall be compacted to 70% relative density (minimum).

2. At all times unfinished construction shall have adequate drainage upon completion of the road’s surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

3. Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out in rainy weather.

4.6 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil. For expansive soils, the fill materials and other protections etc. to be used under the foundation is to be got approved by the NEA/Consultant.

4.7 DISPOSAL OF SURPLUS EARTH

The surplus earth generated from foundation work shall be disposed away from levelling area boundary at low lying areas within 2Km lead. The surplus earth if disposed within substation main boundary, the same shall be spread in uniform layers and compacted with suitable compacting equipment to achieve 95% compaction at O.M.C.

5. ANTIWEED TREATMENT & STONE SPREADING

5.1 SCOPE OF WORK

The Contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification.

Stone spreading along with cement concrete layer shall be done in the areas of the switchyard under present scope of work within fenced area. However the stone spreading along with cement concrete layer in future areas within fenced area shall also be provided in case step potential without stone layer is not well within safe
5.2 GENERAL REQUIREMENT

The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the Purchaser.

The material to be used for stone filling/site surfacing shall be uncrushed/crushed/broken stone of 40mm nominal size (ungraded single size) conforming to relevant BS. Hardness, flakiness shall be as required for wearing courses shall be as are per relevant BS.

(a) Hardness
   Abrasion value as per relevant BS.
   Impact value as per relevant BS.

(b) Flakiness Index
   One test shall be conducted as per relevant British standard codes (B S Codes)/ equivalent International Standards.

After all the structures/equipments are erected, anti weed treatment shall be applied in the switchyard where ever stone spreading along with cement concrete is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type of chemical to be used. The anti weed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer’s recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10MX10M (aprx.) and shall be sprinkled with water at least once in the afternoon every day after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the NEA/Consultant. The final approval shall be given by NEA/Consultant based on the results.

NEA/Consultant shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.

After anti weed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by NEA/Consultant. The sub grade shall be consolidated by using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.

In areas that are considered by the NEA/Consultant to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.

The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be
ensured that no pools of water or soft patches are formed on the surface.

Over the prepared sub grade, 75mm thick base layer of cement concrete in 1:5:10 (1 cement : 5 sand : 10 Stone aggregates) shall be provided in the area excluding roads, drains, cable trenches as per detailed engineering drawing. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at the top of base layer of cement concrete in 1:5:10. A layer of cement slurry of mix 1:6 (1 cement: 6 sand) shall be laid uniformly over cement concrete layer. The cement consumption for cement slurry shall not be less than 150 kg. Per 100 sq.m.

A final layer of 100mm thickness of uncrushed/crushed/broken stone of 40mm nominal size (ungraded size) shall be spread uniformly over cement concrete layer after curing is complete.

6. **SITE DRAINAGE**

Preparation of overall drainage layout, design, drawing and providing rain water drainage system within the substation boundary under the present scope including connection at one or more points to the outfall point located outside the substation boundary wall is in the scope of contractor. Invert level of drainage system at outfall point shall be decided in such a way that the water can easily be discharged outside the substation boundary wall. In case outfall point is more than 50M away from boundary wall, only 50 metre drain outside the boundary wall is in the scope of contractor. Outfall point shall be got approved from NEA/Consultant before commencement of construction. While designing the drainage system following points shall taken care of:

(a) The surface of the switchyard shall be sloped to prevent accumulation of water.
(b) Drain shall be constructed at suitable locations in such a way that substation is not flooded and roads are not affected with ponding of surface water. In the switchyard maximum spacing between two drains shall not be more than 100 meter. It will be ensured that no area is left undrained.
(c) Open surface drains having 300mm bottom width and 300mm depth at starting point of drain shall be provided. The depth of drain shall be measured with respect to finished ground level of switch yard i.e. from bottom of switch yard stone filling.
(d) Longitudinal slope shall not be less than 1 in 1000.
(e) Open surface drains shall be constructed with brick masonry or concrete blocks. As per design of contractor, PCC (1:2:4) shall be laid over 40mm thick layer of PCC 1:4:8 (1 cement: 4coarse sand: 8 stone aggregate 20mm nominal size.)
(f) The side wall of the drains shall be 25 mm above the gravel level to prevent falling of gravel into drain. Groove of 125 mm width shall be provided at 2000 mm spacing with suitable mild steel grating..
(g) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum non-silting velocity of 0.6m/sec shall be ensured.
(h) Pipe drains shall be provided in areas of switchyard where movement of crane will be necessary in operating phase of the substation.
(i) For pipe drains, concrete pipe of class NP2 shall be used. However, for road
crossings etc. higher strength pipe of class NP3 shall be provided. For rail crossings, RCC pipes of class NP4 shall be provided. For design of RCC pipes for drains and culverts, relevant British standard codes (B S Codes)/ equivalent International Standards. Shall be followed.

(j) Two Nos. of portable pumps of 5 hp capacity for drainage of water shall be provided by the Contractor.

(k) Pipe drains shall be connected through manholes at an interval of max. 30m.

(l) If the invert level of outfall point is above the last drain point in the substation boundary, sump of suitable size has to be constructed with in the substation boundary.

(m) The drainage scheme and associated drawings shall be got approved from NEA/Consultant before commencement of construction.

6.1 RAINWATER HARVESTING:

In addition to drainage of rainwater in accordance with above clause 6.0, the contractor shall design, prepare drawings and provide rainwater harvesting system also. Rainwater harvesting shall not be done if the depth of underground water table is within 8.0m from finished ground level or as per provision of relevant British standard codes (B S Codes)/ equivalent International Standards. While designing the rain water harvesting system, following points may be taken care of:

Rainwater harvesting shall be done by providing two numbers recharge structures with bore wells. The recharge structures shall be suitably located within the substation. Branch drains from the main drain carrying rainwater from entire switchyard, constructed in accordance with clause 5.0, shall be connected to the recharge structures.

The internal diameter of recharge shafts shall be 4.5 meter with 230mm thick lining of brick work up to a depth of 2.0 meter from ground level and 345mm thick brickwork below 2.0 meter depth. The brick/concrete block work shall be constructed with cement mortar 1:6 (1 cement: 6 coarse sand). The overall depth of shaft shall be 5.0 meter below invert level of drain. The shaft shall be covered with RCC slab for a live load of 300 kg. Per sq.m. Two openings of size 0.7 x 0.7 meter shall be provided in the RCC cover slab as shown in the drawing. An iron cover made of 5mm thick chequered plate with hinges shall be provided on the openings. Galvanized M.S. rungs of 20mm diameter at spacing of 300 mm shall be provided in the wall of shaft below the opening in the RCC slab to facilitate cleaning of shaft.

A 300 mm diameter bore well shall be drilled in the centre of the shaft. The depth of bore well shall be 5.0 meter more than the depth of sub soil water.

A 100 mm dia medium duty MS pipe conforming to relevant BS shall be lowered in the bore well keeping bail plug towards bottom of bore well. The pipe shall have 1.58mm holes for 4.0 meter length starting from 1.0 meter from bottom of bore well. Holes of 3.0mm dia shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and down wards. The overall length of pipe shall be equal to total depth of bore well plus depth of shaft.

Gravel of size 3mm to 6mm shall be filled around 100 dia MS pipe in the borewell. The shaft shall be filled with 500 mm thick layers each from the bottom of shaft with boulders of size 50mm to 150mm, gravel of size 5mm to 10mm, coarse sand having particle size 1.5mm to 2.0mm and boulders of size not less than 200mm respectively.
7. ROADS

a) All the roads as shown in the General Arrangement drawing for the substation issued along with the tender documents are in the present scope. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the Transformer /Reactor shall be as short and straight as possible.

b) All concrete roads within substation boundary wall shall be with 3.75 m RCC concrete pavement of suitable thickness and 1.3 m wide earthen shoulder on either side of the road. Below RCC concrete pavement, water bound macadam of adequate thickness as per design (WBM) shall be laid.

c) All black top (Bituminous/Asphalt) roads within substation boundary wall if any shall be with 3.75 m asphaltic pavement of suitable thickness and 1.3 m wide earthen shoulder on either side of the road. Below black top pavement, water bound macadam of adequate thickness as per design (WBM) shall be laid.

d) Strengthening of existing roads as applicable (as shown in General Arrangement Drawing) shall be carried out with 2.5 cm thick premix carpet and 100 mm thick compacted layer of WBM (Water Bound Macadam) after filling the pot holes of existing roads with WBM material.

e) All roads shall be designed as per relevant British standard codes (B S Codes)/equivalent International Standards. All drawings of road and culverts shall be prepared by the contractor.

f) All the culverts and allied structures (required for road/rail, drain, trench crossings etc.) shall be designed as per relevant British standard codes (B S Codes)/equivalent International Standards.

8. TRANSFORMERS/REACTOR FOUNDATION, RAIL TRACK/RAIL CUM ROAD TRACK

The Contractor shall design, prepare drawing and provide a RCC Rail cum road system integrated with the Transformer/Reactor foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil. This system shall enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with relevant BS.

The Contractor shall provide a pylon support system for supporting the fire fighting system.

Each Transformer /Reactor including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the Transformer/Reactor shall be 20% of the Transformer /Reactor height or 0.8m whichever is more. The oil collection pit thus formed shall have a void volume equal to 200% volume for 220 kV & above and 130% for 132 kV & below of total oil in the Transformer /Reactor. The minimum height of the retaining walls shall be 15 cm above the finished level of the ground to
avoid outside water pouring inside the pit. The bottom of the pit shall have an uniform slope towards the sump pit. While designing the oil collection pit, the movement of the Transformer must be taken into account.

The grating shall be made of MS flat of size 40mmx 5mm placed at 30mm center to center and 25mmx5mm MS flat at spacing of 150mm at right angle to each other. Maximum length of grating shall be 2000mm and width shall not be more than 500mm. The gratings, supported on ISMB 150mm, shall be placed at the formation level and will be covered with 100mm thick layer of broken/crushed/non-crushed stone having size 40mm to 60mm which acts as an extinguisher for flaming oil. All steel works used for grating and support in transformer foundation shall be painted with Zinc phosphate primer (two packs) conforming to relevant British standard codes (B S Codes)/ equivalent International Standards.

Each oil collection pit shall be drained towards a sump pit within the collection pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

8.1 MATERIALS

Complete foundation shall be made of reinforced cement concrete and shall be designed as per guidelines for design of foundations given in clause 10.0 in the specification.

8.2 DRAINAGE

One 0.5 H.P pump for each pit shall be supplied and installed by the Contractor to evacuate the firefighting & rain water from the sump pit in to the nearest drain.

9. FIRE PROTECTION WALLS

9.1 GENERAL

Fire protection walls shall be provided, if required, in accordance with Local Advisory Committee (LAC) recommendations. The scope of works covers design, preparation of drawing and construction of RCC fire protection walls. While designing the wall, following points may be taken care of:

9.1.1 FIRE RESISTANCE

The firewall shall have a minimum fire resistance of 3 hours. The partitions, which are made to reduce the noise level, shall have the same fire resistance. The walls of the building, which are used as firewalls, shall also have a minimum fire resistance of 3 hours.

The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

9.1.2 DIMENSIONS

The firewall shall extend 600 mm on each side of the Transformer /Reactors and 600 mm above the conservator tank or safety vent.
These dimensions might be reduced in special cases, as per the approval of owner where there is lack of space. A minimum of 2.0 meter clearance shall be provided between the equipment e.g. Transformer /Reactors and firewalls.

The building walls, which act as firewalls, shall extend at least 1 m above the roof in order to protect it.

9.1.3 MATERIALS

The firewall will be made of reinforced cement concrete as per the relevant British standard codes (B S Codes)/ equivalent International Standards.

10. CABLE TRENCHES AND CABLE TRENCH CROSSINGS

The work covered under this clause comprises of design, drawing and construction of cable trenches and cable trench crossings. While designing, following points may be taken care of:

a) The cable trenches and pre-cast removable RCC cover (with lifting arrangement) shall be constructed using RCC of M25 (Minimum) grade as per relevant British standard codes (B S Codes)/ equivalent International Standards.

b) The cable trench walls shall be designed for the following loads.

   (i) Dead load of 155 kg/m length of cable support + 75 Kg on one tier at the outer edge of tier.

   (ii) Earth pressure + uniform surcharge pressure of 2T/m2.

c) Cable trench covers shall be designed for self-weight of top slab + concentrated load of 150 kg at centre of span on each panel.

d) Necessary sumps shall be provided and each sump shall be provided with pumps of 5 HP capacity shall be supplied for pumping out water collected in cable trench. Cable trenches shall not be used as storm water drains.

e) The top of trenches shall be kept at least 100 mm above the finished ground level. The top of cable trench shall be such that the surface rainwater do not enter the trench.

f) All metal parts inside the trench shall be connected to the earthing system.

g) Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

h) The trench bed shall have a slope of 1/500 along the run & 1/250 perpendicular to the run.

i) Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12mm thick 1:6 cement sand mortar.

j) Cable trench crossings shall be designed for critical load likely to be passed
over the crossing. The cable trench crossing may be of either RCC box culvert type or RCC hume pipes embedded in plain concrete as per design of contractor.

11. FOUNDATION / RCC CONSTRUCTION

11.1 GENERAL

1. Work covered under this Clause of the Specification comprises the design, drawing and construction of foundations and other RCC constructions for switchyard tower structures, bus supports, equipment supports, cable trenches, Transformer /Reactors, jacking pad, pulling blocks, fire protection walls, control cubicles, marshalling kiosks, auxiliary equipment, Control Room Cum Administrative building, GIS hall, Firefighting Pump house, firefighting water tanks, Auxiliary Building, Panel room, township buildings, Parking shed, RCC retaining wall, or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

2. Concrete shall conform to the requirements mentioned in relevant British standard codes (B S Codes)/ equivalent International Standards. And all the tests shall be conducted as per relevant British standard codes (B S Codes)/ equivalent International Standards. However, a minimum grade of M25 (design Mix) concrete shall be used for all foundations and structural/load bearing members as per relevant British standard codes (B S Codes)/ equivalent International Standards.

3. If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

4. The switchyard foundation’s plinths and building plinths shall be minimum 300mm and 500 mm above finished ground level respectively.

5. Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

6. Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

7. The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

8. If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under reamed type as per relevant parts of relevant British standard codes (B S Codes)/ equivalent International Standards. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall
be submitted by the contractor showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

11.2 DESIGN

While designing foundations, following may be taken care of:

11.2.1. All foundations except for external lighting poles shall be of reinforced cement concrete. The external lighting pole shall be embedded in plain cement concrete (1:2:4) foundation. The design and construction of RCC structures shall be carried out as per relevant BS and minimum grade of concrete shall be M-25 (design Mix). Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the NEA/Consultant.

11.2.2. Limit state method or any other method as per relevant British standard codes (B S Codes)/ equivalent International Standards of design shall be adopted unless specified otherwise in the specification.

11.2.3. For detailing of reinforcement relevant BS followed. Cold twisted deformed bars conforming to relevant British standard codes (B S Codes)/ equivalent International Standards. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement shall be as per relevant British standard codes (B S Codes)/ equivalent International Standards.

11.2.4. RCC water retaining structures like storage tanks, etc. shall be designed as un-cracked section in accordance with relevant British standard codes (B S Codes)/ equivalent International Standards. However, water channels shall be designed as cracked section with limited steel stresses as per relevant BS.

11.2.5. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant British standard codes (B S Codes)/ equivalent International Standards of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

11.2.6. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

11.2.7. Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.

11.2.8. RCC columns shall be provided with rigid connection at the base.

11.2.9. All sub-structures shall be checked for sliding and overturning stability during both
construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant British standard codes (B S Codes)/ equivalent International Standards or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

11.2.10. Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

11.2.11. In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.

11.2.12. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

   a) Full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).

   b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

   c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

11.2.13. Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

11.2.14. Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.

11.2.15. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

11.2.16. The foundations of transformer/reactor and circuit breaker shall be of lock type foundation. Minimum reinforcement shall be governed by relevant British standard codes (B S Codes)/ equivalent International Standards.

11.2.17. The tower and equipment foundations shall be checked for a factor of safety as per relevant British standard codes (B S Codes)/ equivalent International Standards for two conditions i.e. Normal condition and short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor over loads in limit state design also.
11.3 **ADMIIXTURES & ADDITIVES**

11.3.1. Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

11.3.2. Admixtures in concrete shall conform to relevant British standard codes (B S Codes)/ equivalent International Standards. The water proofing cement additives shall conform to relevant BS. Concrete Admixtures/ Additives shall be approved by NEA/Consultant.

11.3.3. The Contractor may propose and the NEA/Consultant may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

11.3.4. The water-reducing setting-retarding admixture shall be an approved brand as per relevant British standard codes (B S Codes)/ equivalent International Standards.

11.3.5 The water proofing cement additives shall be used as required/advised by NEA/Consultant.

12. **CHAINLINK FENCING AND GATE**

12.1 **General**

Work covered under this clause comprises of design, drawing, supply, fabrication, erection, painting or galvanisation as specified etc of switch yard Fencing and gate, construction of foundation of steel posts and toe wall .While providing switch yard fencing and gate, Following points may be taken care of:

12.2 **Areas requiring Fencing**

12.2.1 Fencing shall be provided for complete switchyard as per drawing. Separate gate shall be provided for men and equipment.

12.2.2 Internal fence surrounding the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.

12.3 **Product materials**

The minimum requirements are as follows:
Chain link fence fabric (galvanization) in accordance to relevant British standard codes (B S Codes)/ equivalent International Standards.

12.4 **Posts**

The posts shall be of medium M.S. tubes of 50mm diameter conforming to grade as per relevant international /BS standard. The tubes shall also conform relevant British standard codes (B S Codes)/ equivalent International Standards. The length of tubular post shall be 2600 mm.

An M.S. base plate of size 160 X 160 X 6mm thick shall be welded with the tubular
post. The post shall be provided on the top with M S plate.

The tubular post shall be welded with 8 number of M S flat of size 50 x 6mm – 75mm long at suitable locations. Two number of 13.5 mm diameter holes on each cleats shall be provided to bolt the fence fabric panel. The cleats shall be welded at equal spacing in such a way that 4 numbers of cleats are on one side and remaining 4 cleats are on the opposite side of the post. The cleats on the corner posts shall be welded in such a way that it suits the site requirement.

The whole assembly of tubular post shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per sq. meter. The purity of zinc shall be 99.95% as per relevant BS.

12.5 Fence Fabric & Fence Panel

Chain link fencing shall be made of 3.15 mm diameter wire with 75 X 75 mm mesh size. Fence fabric shall be galvanised. Chain link fencing shall be fabricated in the form of panel 1300 X 2928 mm. An M.S. flat of at least 50x6 mm size shall be welded all-round fence fabric to form a panel. Four pairs of 13.5mm diameter holes on the vertical M S flat matching the spacing of holes in cleats fixed with pipe shall be provided to fix the fence panel with the tubular posts. A washer shall also be provided below each nut. The contractor, for fixing the panels, shall supply the 12mm diameter bolts including nuts and washers. All nuts, bolts and washers shall be hot dip galvanized.

The fence panel shall be provided with two or more coats of approved standard Zinc paint over approved standard steel primer.

12.6 Installation

1. Fence shall be installed along the switchyard line as shown in the approved drawings.
2. Post holes shall be excavated by approved method.
3. All posts shall be 3.0m apart measured parallel to ground surface.
4. Posts shall be set in 1:2:4 Plain Cement Concrete block of minimum 0.40x0.40x1.2m depth. 75mm thick plain cement concrete 1:4:8 shall be provided below concrete blocks. Posts shall be braced and held in plumb position and true alignment and elevation until concrete has set.
5. Fence fabric shall not be installed until concrete has cured a minimum of 7 days.
6. Fence fabric panel shall be fixed to the post at 4 nos. MS flat each of 50x6, 75 long through 2 nos. of bolts (12mm diameter) on each flat.

12.7 Gate

1. The gate shall be made of medium duty M.S. pipe conforming to relevant I.S. with welded joints. The main frame (outer frame) of the gate shall be made of 40mm diameter pipe and vertical pipes of 15mm diameter @ 125mm spacing (maximum) shall be welded with the main frame. Two numbers of 1.25 mm thick and 125 mm wide MS plates (Horizontal) @ 500 mm centre to centre distance shall be welded on each gate leaf. Gate leaves shall be fixed with a vertical post of 2700 mm long two steel channels-150 welded together. A 8 mm thick 200X 200 mm size MS plate shall be welded
at the bottom of channel frame.

2. The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.

3. The gates shall be provided with suitable locking arrangement welded on 4 mm thick MS plate on the gate leaf.

4. The main gate shall be 5.0m wide and shall be of double leaf type (as shown in the drawing). Next to the main gate, a men gate (1.25m wide single leaf) shall also be provided.

5. Steel roller shall be provided with the gate.

6. Gate shall be installed in location as shown in approved G.A. drawing.

7. The vertical post of gate shall be embedded in PCC foundation of 500 X500X1250 mm deep size.

13. **BUILDINGS**

13.1 **GENERAL**

The scope includes the design, drawing, engineering and construction including anti-termite treatment, plinth protection, DPC of Building including sanitary, water supply, electrification, false ceiling etc as applicable, complete of control room building, firefighting building, Auxiliary building and panel room. Electrification and air conditioning of building shall be provided as detailed in other sections of electrical portion.

13.2 **CONTROL ROOM CUM ADMINISTRATIVE BUILDING**

**GENERAL**

The scope includes design, engineering and construction, including anti-termite treatment, plinth protection, DPC, peripheral drains, water supply, plumbing, sanitation, fire-fighting, electrification etc. of Control Room Building. The Control Room Building shall be of size 20 m X 25 m approximately. It will be a double storeyed RCC Framed structure if constructed separately away from GIS hall. It shall be so designed that most of the area of switchyard is visible from the Control Room. The building auxiliary services like air conditioning systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements as specified in relevant section or elsewhere in this Specification. The building shall be constructed as per the design and drawings to be developed by the contractor. Tentative carpet area requirement for different rooms of control room cum administrative building is given as below for guidance to the contractor:

**AREA REQUIREMENTS**

- Control Room 37 sq.m.
- ACDB & DCDB Room 145 sq.m. or As per requirement.
- Battery Room 48 sq. m or As per requirement.
• Electrical Lab 23 sq.m.
• Conference Room with attached Toilet 33 sq.m.
• Telecom Room As per requirement
• S/S-In-charge office with attached Toilet 27 sq.m.
• Room for executives 55 sq.m.
• Room for non-executives 40 sq.m.
• Lobby -Reception 25 sq.m.
• Corridor width Minimum width of corridor shall be 1800 mm.
• Portico 25 sq.m. (approx.).
• Common Toilet-Men 7 sq.m.
• Toilet for Women 4 sq.m.
• Janitor Room 3 sq.m.
• Pantry 7 sq.m.
• Provision of shaft for electrical, sanitary, water supply facilities shall also be kept.

13.3 DESIGN CRITERIA
The Building shall be designed:
1. To the requirements of the International standards/British Standards.
2. For the specified climatic and loading conditions.
3. To adequately suit the requirements of the equipments and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
4. with a functional and economical space arrangement.
5. To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design, as far as possible.
6. To allow for easy access to the equipments as well as maintenance of the equipment.
7. Wherever access to the roof is required, RCC stair case shall be provided.
8. Fire retarding materials for walls, ceilings doors etc., which would prevent supporting or spreading of fire and wherever required, shall be decided by the bidder.
9. Suitable Expansion joints, wherever required, shall be provided as per Codal Provisions.
10. All the members of the buildings frame shall be designed for the worst
combination of loads as per relevant British standard codes (B S Codes)/ equivalent International Standards.

11. Permissible stresses for different load combinations shall be taken as per relevant British standard codes (B S Codes)/ equivalent International Standards.

12. Seismic coefficient Method or Response spectrum method shall be used for seismic analysis of the building for Earthquake forces, as per relevant British standard codes (B S Codes)/ equivalent International Standards.

13.4 DESIGN LOADS

1. Building structure shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, erection loads, wind loads, seismic loads etc. Any other incidental load, if anticipated, shall be duly accounted for in the design, and shall be clearly mentioned by the bidder.

2. Dead loads shall include the weight of structures complete with finishes, fixtures and partitions, and shall be taken as per relevant British standard codes (B S Codes)/ equivalent International Standards.

3. Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads, wherever these loads are expected. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.

<table>
<thead>
<tr>
<th>AREA</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For Offices.</td>
<td>5.0 kN/m²</td>
</tr>
<tr>
<td>If higher than 5.0 kN/m²</td>
<td>As per actual Requirement.</td>
</tr>
<tr>
<td>2. For Equipment Floors.</td>
<td>10.0 kN/m²</td>
</tr>
<tr>
<td>If higher than 10 kN/m²</td>
<td>As per actual Requirement.</td>
</tr>
<tr>
<td>3. Staircases &amp; Balconies.</td>
<td>5.0 kN/m²</td>
</tr>
<tr>
<td>4. Toilets.</td>
<td>2.0 kN/m²</td>
</tr>
<tr>
<td>5. Chequered Plate.</td>
<td>4.0 kN/m²</td>
</tr>
<tr>
<td>6. Corridors/Walkways.</td>
<td>3.0 kN/m²</td>
</tr>
<tr>
<td>7. Accessible Roofs.</td>
<td>1.5 kN/m²</td>
</tr>
<tr>
<td>8. Non-accessible Roofs.</td>
<td>0.75 kN/m²</td>
</tr>
</tbody>
</table>

4. Wind loads shall be calculated as per relevant British standard codes (B S
5. Earthquake loads shall be calculated as per relevant British standard codes (B S Codes)/ equivalent International Standards.

6. Wind forces and Seismic forces shall not be considered to act simultaneously.

7. All the load combinations to create worst combinations of loads shall be as per relevant International standards/British Standards.

8. Floors/ Slabs shall be designed to carry loads imposed by equipments, cables, piping, movement of maintenance trucks (if required) and any other load associated with the building. In general, floors shall be designed for live loads as per relevant British standard codes (B S Codes)/ equivalent International Standards. Cable and piping loads shall also be considered in addition to the live loads for floors where these loads are expected.

13.5 FLOORS, WALLS & ROOFS

1. All walls shall be non-load bearing in filled panel walls, in brickwork as per the specification. Minimum thickness of external walls shall be 230 mm (one brick) with 1:6 cement sand mortar. Partition walls if any shall be of 115 mm thick brick masonry in cement sand mortar (1:4).

2. All Floor/Roof slabs shall be regular beam slab construction. However, sunken RCC slab shall be provided in toilet areas as per the requirement.

3. False ceiling as per requirement shall be provided as detailed in Table-1 (Detailed Finish Schedule).

4. Minimum height of skirting above finished floor level shall be 150 mm. The skirting material shall match with the floor finish.

5. Minimum height of the parapet walls shall be 750 mm.

6. Ground floor finish shall be laid over 20 mm thick cement sand mortar, 100 mm thick plain cement concrete (PCC) 1:4:8 (1 cement: 4 sand : 8 stone aggregates), 100 mm thick local sand filling. The earth below ground floor shall be well rammed before laying sand filling.

7. First floor details shall comprise of finish as per schedule, 20 mm cement sand mortar and 50 mm thick PCC(1:4:8) over RCC slab.

13.6 DETAILS OF ROOF

Roof of the Building shall consist of Cast-in-situ RCC slab treated with a waterproofing system which shall be an integral cement based treatment conforming to relevant British standard codes (B S Codes)/ equivalent International Standards. The waterproofing treatment shall be of following operations:

(a) Applying and grouting a slurry coat of neat cement using 2.75 kg/m² of cement admixed with proprietary waterproofing compounds conforming to relevant British standard codes (B S Codes)/ equivalent International Standards. Over the RCC slab including cleaning the surface before treatment.

(b) Laying cement concrete using broken stone of size from 25mm to 100mm size with 50% of cement mortar 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to relevant British standard codes (B S Codes)/ equivalent International Standards over 20mm thick layer of cement mortar of min 1:5 (Cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to relevant British standard codes (B S Codes)/ equivalent International Standards to required slope and treating similarly the adjoining walls up to 300mm height including rounding.
of junctions of walls and slabs.

(c) After two days of proper curing applying a second coat of cement slurry admixed with proprietary water proofing compound conforming relevant British standard codes (B S Codes)/ equivalent International Standards.

(d) Finishing the surface with 20mm thick joint less cement mortar of mix 1:4 (1 cement: 4 course sand) admixed with proprietary water proofing compound conforming to relevant British standard codes (B S Codes)/ equivalent International Standards and finally finishing the surface with trowel with neat cement slurry and making of 300 x 300 mm square.

(e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-charge.

(f) Average thickness of water proofing shall be 120 mm and minimum thickness at khurra shall be 65 mm.

13.7 PARTITIONS

Partitions wherever provided, shall be made of powder coated aluminium frame provided with 5.5 mm thick clear glass or pre-laminated board depending upon the location of partition.

13.8 PLASTERING

External surfaces of buildings shall have 18 mm thick plaster in two layers, with the under layer 12mm thick 1:5 cement sand plaster and the top layer 6 mm thick 1:6 cement sand plaster. Inside wall surfaces shall have 12/15 mm thick 1:6 cement sand plaster. Rough surfaces shall have 15mm and smooth surface shall have 12 mm thick cement sand plaster.

All RCC ceilings shall be provided with 6 mm thick cement sand (fine) plaster (1:3) except for areas with false ceiling.

13.9 EXTERNAL PAINTING

External surfaces of the Control Room Building shall be painted with acrylic exterior flat paint as per manufacturer’s specification and approval of NEA/Consultant.

13.10 DOORS, WINDOWS AND VENTILATORS

The schedule of doors, windows and ventilators of the Control Room Building shall be as per the detailed finish schedule given in Table-1 (Detailed Finish Schedule), and shall conform to the relevant British standard codes (B S Codes)/ equivalent International Standards. Rolling Steel shutters shall be provided as per the layout and requirements of the building. Main entrance door to control room building shall be made of powder coated aluminium frame with 5.5 mm thick glazing.

13.11 CABLE TRENCH INSIDE CONTROL ROOM BUILDING

All cable trenches inside the Control Room Building shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners.

13.12 PLINTH PROTECTION

750 mm wide and 50 mm thick plain cement concrete 1:2:4 (1 cement:2 sand:4 graded 20 mm nominal size stone aggregate ) shall be laid over 75 mm thick dry stone aggregates well rammed and consolidated with interstices filled with local sand including smooth finishing top.

13.13 PLUMBING & SANITATION

1. All plumbing and sanitation works shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange
for all necessary formalities to be met with regards to the inspection, testing, obtaining approval and giving notices etc.

2. ‘SINTEX’ or an equivalent make PVC Roof water tank(s) of adequate capacity depending on the number of users for 24 hours storage shall be provided. However, a minimum of 2 nos. 1500 liter capacity shall be provided.

3. Chlorinated Polyvinyl chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threading conforming to relevant British standard codes (B S Codes)/ equivalent International Standards shall be used for internal piping works for water supply.

4. Sand C.I. pipes with lead joints conforming to relevant British standard codes (B S Codes)/ equivalent International Standards shall be used for sanitary works above ground level and RCC pipes shall be used for sanitary works below ground.

5. Each toilet shall have the following minimum fittings:
   (i) WC (Western type) 390 mm high along with toilet paper roll holder and all other fittings, in toilets attached to conference room and S/S In-charge office; and WC (Indian Type) Orissa Pattern (580 x 440 mm) with all fittings shall be provided in common toilets.
   (ii) Urinal (430 x 260 x 350 mm size) with all fittings and built-in-sensor for automatic flush after use.
   (iii) Wash basin (550 x 400 mm) with all fittings.
   (iv) Bathroom mirror (600 x 450 x 6 mm thick) with hard board backing.
   (v) CP brass towel rail (600 x 20 mm) with CP brass brackets.
   (vi) Soap holder and liquid soap dispenser.
   (vii) Automatic Hand Dryer.

6. Water cooler for drinking water with adequate water storage facility shall be provided which shall preferably be located near pantry and away from the toilet block.

7. One no. stainless steel kitchen sink with Drain board (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.

8. All fittings, fasteners, gratings shall be chromium plated.

9. All sanitary fixtures and fittings shall be of approved quality and type, manufactured by reputed manufacturers. All items brought to site must bear identification marks of the Manufacturer.

10. Contractor shall provide necessary nos. of septic tank and soak pit of adequate capacity to treat the sewage/sullage from the buildings.

11. Contractor shall undertake all other activities required to complete and commission the building.

13.14 BUILDING STORM WATER DRAINAGE

1. The building design shall provide for the collection of storm water from the roof. This water shall be drained to the main drainage system of the Sub-station.

2. Cast Iron Rainwater down comer pipes conforming to relevant International standards/British Standards with water tight lead joints or medium class galvanized mild steel pipes conforms to relevant British standard codes (B S Codes)/ equivalent International Standards shall be provided to drain off the
Rain water from the roofs. These pipes shall be suitably concealed with masonry work or cement concrete or cladding material. The number and size of down comer pipes shall be governed by relevant British standard codes (B S Codes)/ equivalent International Standards.

3. All drains inside the buildings shall have minimum 40 mm thick grating covers; and in areas where heavy equipment loads are envisaged, Pre-Cast RCC covers shall be provided in place of steel grating.

4. Suitable arrangements for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided for each floor.

13.15 DETAILED FINISH SCHEDULE

The detailed finish schedule for Control Room Building Cum Administrative building is given below:

Table- 1: DETAILED FINISH SCHEDULE

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>LOCATION</th>
<th>FLOORING &amp; SKIRTING 150 MM HIGH</th>
<th>WALL(INTERNAL)</th>
<th>CEILING</th>
<th>DOOR, WINDOWS &amp; VENTILATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control Room</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>White wash above False Ceiling*</td>
<td>Windows shall be of 10mm thick toughened glass by using suitable patch fittings/spider fittings. The glass shall extend horizontally from column to column and vertically from sill level of 0.75 m to bottom of lintel/roof beam. All doors shall be glazed powder coated aluminium doors with 5.5.mm Thk. Glazing.</td>
</tr>
<tr>
<td>2.</td>
<td>Conference Room</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>White wash above False Ceiling*</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing</td>
</tr>
<tr>
<td>3.</td>
<td>S/S In-charge Room.</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>White wash above False Ceiling*</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5.mm thk. Glazing</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>LOCATION</td>
<td>FLOORING &amp; SKIRTING 150 MM HIGH</td>
<td>WALL(INTERNAL)</td>
<td>CEILING</td>
<td>DOOR, WINDOWS &amp; VENTILATOR</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------</td>
<td>----------------------------------</td>
<td>----------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Office Rooms</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>White wash above False Ceiling*</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>5</td>
<td>Electrical/Electronic Test Lab/Telecom Room</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>White wash above False Ceiling*</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>6</td>
<td>ACDB &amp; DCDB Room</td>
<td>62mm thick cement concrete flooring with metallic hardener topping. Skirting shall be of cement sand plaster.</td>
<td>Oil bound washable distemper on smooth surface applied with plaster of paris putty</td>
<td>Oil bound washable distemper on smooth surface applied with plaster of paris putty</td>
<td>Steel door 45mm thick double sheet 18 gauge MS steel suitably reinforced and filled with mineral wool. Windows/ventilator shall be of powder coated aluminium with 4mm glazing.</td>
</tr>
<tr>
<td>7</td>
<td>Battery Room</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>White wash above False Ceiling*</td>
<td>Steel door 45mm thick double sheet 18 gauge MS steel suitably reinforced and filled with mineral wool. Windows/ventilator shall be of powder coated aluminium with 4mm glazing.</td>
</tr>
<tr>
<td>8</td>
<td>Reception/Lobby</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>Oil bound washable distemper on smooth surface applied with plaster of paris putty</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>9</td>
<td>Corridor</td>
<td>Vitrified tiles 8mm thick size 600 x</td>
<td>Premium acrylic emulsion paint on smooth surface</td>
<td>Oil bound washable distemper</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>LOCATION</td>
<td>FLOORING &amp; SKIRTING 150 MM HIGH</td>
<td>WALL(INTERNAL)</td>
<td>CEILING</td>
<td>DOOR, WINDOWS &amp; VENTILATOR</td>
</tr>
<tr>
<td>-------</td>
<td>------------------</td>
<td>---------------------------------</td>
<td>----------------------------------</td>
<td>--------------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>10</td>
<td>Portico</td>
<td>600mm</td>
<td>applied with plaster of paris (2 mm thick)</td>
<td>on smooth surface applied with plaster of paris putty</td>
<td>thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5 mm thickness Glazing.</td>
</tr>
<tr>
<td>11</td>
<td>Toilet</td>
<td>Ceramic tiles</td>
<td>DADO glazed tile 2100mm high, oil bound washable distemper above DADO</td>
<td>Oil bound washable distemper</td>
<td>Windows/ ventilator shall be of powder coated aluminium with 5.5 mm thick glazing. All doors shall be flush door shutters made of pre-laminated particle board with powder coated aluminium frame.</td>
</tr>
<tr>
<td>12</td>
<td>Janitor room</td>
<td>Ceramic tiles with white cement</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Oil bound washable distemper</td>
<td>Windows/ ventilator shall be of powder coated aluminium with 5.5 mm thick glazing. All doors shall be flush door shutters made of pre-laminated particle board with powder coated aluminium frame.</td>
</tr>
</tbody>
</table>

*Providing and fixing 15mm thick approximately 600 X 600mm Mineral fiber board panel false ceiling and making cut-outs for electrical fixtures, AC diffusers, openable access etc. complete with silhouette profile system with 15mm wide flange incorporating 6mm central recess white/ black main runners at 1200mm centre-centre and not greater than 600mm from the adjacent wall. The cross tees shall be provided to make a module of approximately 600mm X 600mm by fitting 600 mm long cross tees centrally placed between 1200 mm long cross tees. Cross tees also have 15mm wide flange incorporating 6mm central recess white/black. The module formed above shall be anchored to the slab with channels or angles, suspenders as per manufacturer’s specifications.*
The following information/documents/drawings shall be submitted for review and approval:

1. Structural design calculations, Structural drawings (including construction/fabrication), both in hard and soft copies, for all reinforced concrete and structural steel structures.

2. Fully dimensioned and detailed floor plans, cross-sections, longitudinal sections and elevations identifying the major building components.

3. Product information of building components and materials, including walls, partitions, flooring, ceilings, roofing, doors, wall paneling and windows and building finishes along with BOQ.

4. A detailed schedule of building finishes including colors schemes along with item description.

5. A door & window schedule showing door & window types and locations, lock sets and latch sets and other door hardware along with item details.

Approval of the above information shall be obtained before ordering materials or starting construction/fabrication, as applicable.

13.17 **FALSE CEILING**

Providing and fixing seamless ceiling with Gypsum board of 12mm thick fixed to the underside of GI frame work. The GI is fixed to the roof Slab with metal expansion fastener. The joint shall be finished with joint paper tape by using jointing Compound recommended by manufacturer with the approval of NEA/Consultant. The rate includes for all necessary cutting of ceiling for the fixing of complete fixtures.

13.18 **UNDER DECK INSULATION**

The method of fixing shall consist of slotted M.S. angles of appropriate size (minimum 65x50x2mm) fixed to soffit of RCC roof slab at 600mm centres in both directions by Rawl plugs of adequate strength. The slots shall have 14g G.I. tie wire drawn through them.

50mm thick insulation mat Fibreglass Crown - 100 or equivalent shall, be made out of fibre-glass or approved equivalent conforming to IS: 8183, backed with 34g aluminium foil and 22g x 12mm mesh wire netting. The net shall be stretched tightly across the slotted angles or slotted plates holding it in place by means of wires. The joints of the wire netting shall be butted and tightly laced down with 14g G.I. wire. The system shall be got approved from NEA/Consultant.

13.19 **ELECTRIFICATION**

All electrification shall be executed as per details specified elsewhere in the technical specification. All details shall be as per relevant British standard codes (B S Codes)/equivalent International Standards.

14. **FIRE FIGHTING PUMP HOUSE BUILDING**

**GENERAL**

The scope includes design, engineering and construction, including anti-termite treatment, plinth protection, DPC, peripheral drains, fire-fighting, electrification etc. of
firefighting pump house building.

The firefighting pump house building shall be essentially single storied reinforced cement concrete (RCC) framed Building. The building auxiliary services like internal electrification, fire protection systems shall be designed in accordance with the requirements as specified in relevant section of technical Specification. The design and layout of foundation of various pumps and cable trenches inside building shall be prepared by the contractor as per requirement of proposed firefighting system.

AREAS REQUIREMENTS

Dimensions of the Building shall be decided by the bidder depending upon the requirement. The approximate size of building is 12.3m X 7.9mX 4.3 m high. The height of building shall be measured from finished floor level to top of roof slab.

DESIGN CRITERIA

The Building shall be designed:

1. To the requirements of the relevant /British standards/ equivalent International standards quoted therein, and as specified in this specification.
2. for the specified climatic and loading conditions.
3. To adequately suit the requirements of the pumps and firefighting system contained in the buildings and in all respects to be compatible with the intended use and occupancy.
4. with a functional and economical space arrangement.
5. To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design, as far as possible.
6. To allow for easy access to the equipment as well as maintenance of the equipment.
7. G.I. ladder with cage shall be provided for access to the roof.
8. With, wherever required, fire retarding materials for walls, ceilings doors etc., which would prevent supporting or spreading of fire and shall be decided by the bidder.
9. Suitable Expansion joints, wherever required, shall be provided as per Codal Provisions.
10. All the members of the buildings frame shall be designed for the worst combination of Loads as per relevant International standards/British Standards.
11. Permissible stresses for different load combinations shall be taken as per relevant International standards/British Standards.
12. Seismic analysis of the building for Earthquake forces shall be carried out as per relevant International standards/British Standards.

DESIGN LOADS

1. Building structure shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, wind loads, seismic loads etc. Any other incidental load, if anticipated, shall be duly accounted for in the design, and shall be clearly mentioned by the bidder.
2. Dead loads shall include the weight of structures complete with finishes, fixtures and partitions, and shall be taken as per relevant International standards/British Standards.
3. Super-imposed loads in different areas shall include live loads, cable trays, and
small pipe racks/hangers, piping system and erection, operation and maintenance loads wherever these loads are expected.

a) Non-accessible Roof – 0.75 kN/m².
b) Accessible Roof – 150 kN/m².

4. Wind loads shall be calculated as per relevant International standards/British Standards. The Factors affecting the wind speed shall be taken based on the site conditions.

5. Earthquake loads shall be calculated as per relevant International standards/British Standards.

6. Wind forces and Seismic forces shall not be considered to act simultaneously.

7. All the load combinations to create worst combinations of loads shall be as per relevant International standards/British Standards.

8. Floors shall be designed to carry loads imposed by Pumps, cables, piping, movement of maintenance trucks (if required) and any other load associated with the building. In general, floors shall be designed for live loads as per relevant International standards/British Standards. Cable and piping loads shall also be considered in addition to the live loads for floors where these loads are expected.

**FLOORS, WALLS & ROOFS**

The floor shall be constructed with 52 mm thick cement concrete finished with metallic hardener topping. 150 mm thick base plain cement concrete layer, 100 mm thick compacted local sand filling and 200 mm thick hard core of stone ballast with interstices filled with local sand shall be laid below cement concrete flooring top. The earth filling below floor shall be well rammed.

**PLASTERING**

External surfaces of building shall have 18 mm thick plaster in two layers, with the under layer 12 mm thick 1:5 cement sand (coarse) plaster and the top layer 6 mm thick 1:6 cement sand (coarse) plaster. Inside wall surfaces shall have 12/15 mm thick 1:6 cement sand (coarse) plaster. Rough surfaces shall have 15 mm and smooth surface shall have 12 mm thick cement sand plaster. Ceiling shall be plastered with 6 mm thick cement sand plaster (1 Cement: 3 Sand).

**EXTERNAL PAINTING**

External surfaces of the Building shall be painted with acrylic exterior flat paint as per manufacturer’s specification and approval of NEA/Consultant.

**DOORS, WINDOWS AND VENTILATORS**

The schedule of doors, roller shutter, windows and ventilators of the Building shall be of steel as per relevant International standards/British Standards. Rolling Steel shutters shall be provided as per the layout and requirements of the building. Main entrance door to the Building shall be MS door frame with M.S. sheet double shutter. Windows and ventilators shall be of steel made of hot rolled sections windows and ventilators shall be provided with 5.5 mm thick glazing.

**CABLE TRENCH INSIDE FIRE FIGHTING PUMP HOUSE BUILDING**

All cable trenches inside the building shall be covered with minimum 6 mm thick steel chequered plate with suitable stiffeners. The structural steel used for cable tray support, earthing cleat, chequered plates for internal cable trenches of fire fighting pump house building shall be measured and paid under miscellaneous steel item of BPS.
PLINTH PROTECTION

750 mm wide plinth protection all-around the building shall be provided. Plinth protection shall comprise of 50 mm thick PCC (1:2:4) laid over 75 mm thick well compacted stone aggregates with interstices filled with local sand including smooth finishing top.

PARAPET

230 mm thick and 500 mm high brick parapet shall be provided. The parapet shall be plastered with cement sand plaster (1:6).

BUILDING STORM WATER DRAINAGE

1. The building design shall provide for the collection of storm water from the roof. This water shall be drained to the main drainage system of the Sub-station.

2. Cast Iron Rainwater down comer pipes conforming to relevant International standards/British Standards with water tight lead joints or medium class galvanized mild steel pipes conforms to relevant International standards/British Standards shall be provided to drain off the rain water from the roofs. These pipes shall be suitably concealed with masonry work or cement concrete or cladding material.

3. Suitable arrangements for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided, if found necessary.

DETAILS OF ROOF

Roof of the Building shall consist of Cast-in-situ RCC slab treated with a water proofing system which shall be an integral cement based treatment conforming to relevant International standards/British Standards. The water proofing treatment shall be of following operations:

(a) Applying and grouting a slurry coat of neat cement using 2.75 kg/m2 of cement admixed with proprietary water proofing compounds conforming to relevant International standards/British Standards over the RCC slab including cleaning the surface before treatment.

(b) Laying cement concrete using broken stones 25mm to 100mm size with 50% of cement mortar 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to relevant International standards/British Standards over 20mm thick layer of cement mortar of min 1:5 (Cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to relevant International standards/British Standards to required slope and treating similarly the adjoining walls up to 300mm height including rounding of junctions of walls and slabs.

(c) After two days of proper curing applying a second coat of cement slurry admixed with proprietary water proofing compound conforming to relevant British standard codes (B S Codes)/ equivalent International Standards.

(d) Finishing the surface with 20mm thick joint less cement mortar of mix 1:4 (1 cement: 4 course sand) admixed with proprietary water proofing compound conforming to relevant International standards/British Standards and finally finishing the surface with trowel with neat cement slurry and making of 300 x 300 mm square.

(e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-charge.

(f) Average thickness of water proofing shall be 120 mm and minimum thickness at khurra shall be 65 mm.
DETAILED FINISH SCHEDULE

The detailed finish schedule for Fire Fighting Pump House Building is given below:

**Table- 2 : DETAILED FINISH SCHEDULE**

<table>
<thead>
<tr>
<th>S.N No.</th>
<th>LOCATION</th>
<th>FLOORING &amp; SKIRTING 150 MM HIGH</th>
<th>WALL(INTERNAL)</th>
<th>CEILING</th>
<th>ROLLER SHUTTER, DOOR, WINDOWS &amp; VENTILATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fire Fighting Pump House</td>
<td>62mm thick cement concrete flooring with metallic hardener topping. Skirting shall be of cement sand plaster.</td>
<td>Oil bound washable distemper on masonry portion.</td>
<td>As per Manufacturer details.</td>
<td>Windows/ventilator shall be hot rolled steel section with 5.5mm thick glazing. Entry door shall be of M.S. Sheet double shutter and rolling shutter shall be of steel.</td>
</tr>
</tbody>
</table>

ELECTRIFICATION

All electrification shall be executed as per details specified elsewhere in the technical specification. All details shall be as per relevant British standard codes (B S Codes)/equivalent International Standards.

15. AUXILIARY BUILDING

Auxiliary building shall be single storeyed reinforced cement concrete framed structure building. The size of building shall be about 15 m X 20 m approximately. However, bidder may suggest suitable size as per his requirement. The building shall house 11 kV indoor switchgear.

The details like floor details, door, windows, ventilator, internal finish details etc shall match with respective room of RCC control room building. External finish shall also match with control room building.

1. Contractor shall develop the layout in such a way that its aesthetic look is pleasant. The design of Auxiliary building shall be carried out as per relevant International standard/British Standards.

2. The internal cable trenches, panel etc shall be designed by the contractor as per requirement. Layout of these cable trenches, panel layout shall also be prepared by the contractor as per requirement.

CABLE TRENCH INSIDE AUXILLIARY BUILDING

All cable trenches inside the building shall be covered with minimum 6 mm thick steel chequered plate with suitable stiffeners. The structural steel used for cable tray support, earthing cleat, chequered plates for internal cable trenches shall be measured and paid under miscellaneous steel item of BPS.

ELECTRIFICATION

All electrification shall be executed as per details specified elsewhere in the technical
specification. All details shall be as per relevant British standard codes (B S Codes)/ equivalent International Standards.

16. **FIRE FIGHTING WATER TANK**

1. Reinforced cement concrete water tank with two compartments each of size 9.31 m X 9.31 m and capacity of 317 Cubic Meter shall be constructed. A sump of size 2.5 m X 2.5 m x 0.5 m deep shall be provided at one corner in each compartment. Finished floor level of water tank shall be about 200 mm above finished ground level of switch yard. Base slab of water tank shall rest on 75 mm thick plain cement concrete (1:3:6) laid over 800 mm thick well compacted stone packing (Stone Size from 25 mm to 150 mm ) with interstices filled with local sand.

2. The roof of Water tank shall be of Asbestos Corrugated sheet. The sheet shall be supported on suitable steel purlins etc. Suitable gutter shall be provided to drain off rain water.

3. A steel door of size 900 mm X 1850 mm with single shutter made of hot rolled steel section and MS steel door frame shall be provided at about (+) 4.5 m level for access inside water tank.

4. Suitable MS rungs of 20 mm diameter rod @ 300 mm centre to centre staggered on both faces (External and internal) of wall at suitable location shall be provided to act as ladder.

5. Integral water proofing compound of reputed brand shall be added to the concrete and plaster of water tank. Quantity of compound shall be as per manufacturer’s recommendation.

6. All inserts, nozzles, pipe sleeves etc shall be provided during concreting at suitable locations as per fire fighting system. The size is to be decided by the contractor to meet the requirement.

7. Inside surfaces of water tank shall be plastered with cement sand plaster (1 Cement: 6 sand).

8. The outer surface of water tank shall be painted with the paint matching with Fire fighting pump house building.

9. P.V.C. water stopper shall be provided at all construction joints of water tank.

10. The design of water tank shall be carried out as per relevant British standard codes (B S Codes)/ equivalent International Standards.

17. **SWITCH YARD PANEL ROOM**

RCC switchyard panel room with the size as mentioned in bid price schedule shall be constructed. RCC sloped roof shall be provided. The sloped roof shall be covered with suitable tiles to enhance aesthetic look. The floor details (sand, PCC, cement mortar )shall match with that of other buildings. The floor finish shall be provided with vitrified tiles. Plinth protection as per other buildings. The finish details like painting, plaster shall match with other buildings. Doors shall be aluminium glazed .

All walls, floor and roof shall be provided with suitable chicken wire mesh which shall be connected with earthing system through 75 x 12 mm MS flat. Air conditioning and internal electrification of panel room shall be done as mentioned in respective technical specification and BPS in Electrical portion. The size and layout of internal cable trenches of panel room shall be decided by the contractor as per requirement.

All cable trenches inside the panel room shall be covered with minimum 6 mm thick steel chequered plate with suitable stiffeners. The structural steel used for cable tray support, earthing cleat, chequered plates for internal cable trenches shall be measured and paid under miscellaneous steel item of BPS.
The design shall conform to relevant British standard codes (B S Codes)/ equivalent International Standards.

18. CAR PARKING SHED
Aesthetically pleasant RCC car parking shed as per design and drawings as developed by the contractor and suitable to park 10 cars shall be constructed at suitable location to be decided during detailed engineering stage.

19. WATER SUPPLY

(i) Water shall be made available by NEA/consultant at any feasible point within substation boundary at single point to the contractor. Contractor shall state the total water requirement both in terms of quantity and head to NEA/Consultant.

(ii) The contractor shall carry out all the plumbing/erection works required for supply of water in control room cum administrative building beyond the single point as at (i) above.

(iii) The contractor shall carry out all the plumbing/erection works required for supply of water to Fire Fighting pump house beyond the single point as at (i) above.

(iv) The details of tanks, pipes, fittings, fixtures etc for water supply are given elsewhere in the specification under respective sections.

(v) A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall be got approved by NEA/Consultant before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works. All drawings shall be prepared by the contractor for approval of NEA/Consultant.

(vi) Bore wells and pumps for water supply is not in the scope of contractor.

20. SEWERAGE SYSTEM

(i) Sewerage system shall be provided for all buildings wherever applicable.

(ii) The Contractor shall construct septic tank and soak pit suitable for 50 users each for control room building, transit camp and township buildings is constructed. If septic and soak pit system is not acceptable by local Nepal Authority, contractor will have to install suitable sewerage system as per local statutory requirement.

(iii) The system shall be designed as per relevant British standard codes (B S Codes)/ equivalent International Standards. All drawings shall be prepared by the contractor for approval of NEA/Consultant.
21. **GIS HALL CUM CONTROL ROOM BUILDING**

21.1 **CONTROL ROOM AND GIS HALL**

The GIS building shall be of pre-engineered steel structure. Control room building, if attached to GIS hall, shall be of pre-engineered steel structure similar to GIS hall and shall be RCC framed structure, if it is not connected with GIS hall. In case of steel control room building all walls shall be of brick masonry and roof of ground floor shall be of RCC. Internal access to the GIS hall from control room building shall be provided.

Material specification and other details for construction of Pre-engineered steel building shall be as described in subsequent paragraphs. The base plate of steel columns shall be mounted on the RCC foundation by means of hot dip galvanised foundation bolts (Galvanisation of 610 gms/Sq. M). In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Separate fire escape doors shall also be provided in the GIS Building.

Panels shall be kept in an air-conditioned room. Panel room shall be provided with false ceiling. A glazed partition made of aluminium frame and 5.5mm thick glass shall be provided between GIS hall and panel room. The glazing shall be kept at a sill level of 0.9 m above floor level. The height of glazing shall be minimum 3.0 m above sill level.

A Walkway of overall width of not less than 1.0m shall be provided at gantry girder level on the two longer side of GIS hall along with climbing arrangement to facilitate maintenance of crane. Suitable arrangement shall be made on top of the crane to facilitate maintenance of lighting fixtures. Structural steel of walkway shall be finished with priming coat of standard steel primer followed by one coat of epoxy paint and final coating of PU (Minimum 100 Micron).

The walls of GIS building and attached panel/relay/AHU room shall be of full brick/concrete block and upto a height of 150 mm above false ceiling level of panel/relay room. Rest portion of building shall be provided with puff sandwiched panels as mentioned elsewhere in technical specification.

All external openings for duct entries/exits shall be provided with all round sunshades/chajjas to ensure that no rain water shall directly splashes on sealant.

All the material required for Pre-engineered (steel) building shall be procured from reputed manufacturer for which prior approval shall be obtained. Manufacturing of various parts of the building shall start only after approval of “Manufacturing Quality Plan to be prepared by the bidder during detailed engineering stage”. Complete material shall be offered for inspection by QA&I department of Consultant/NEA before dispatch. Inspection shall be carried out based on assembly (fabrication) drawings approved by consultant/NEA and “BILL OF MATERIAL” & Shop drawing prepared by the Manufacturer and certified by the Contractor for its correctness. Approval of BOM and shop drawing from employer is not required.

21.2 **MATERIAL SPECIFICATION**

21.2.1 Primary members fabricated from plates and sections with minimum yield strength of 345 Mpa or to suit design by continuous double side welding.
21.2.2 Secondary members for Purlins and Grits shall conform to the physical specification of ASTM A570 (Grade 50) or equivalent BS/equivalent international standards having a minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 2.5mm.

21.2.3 Rod / ANGLE/pipe bracing shall conform to the physical specification of relevant BS/equivalent international standards of minimum 245Mpa Yield Strength

21.2.4 All hot rolled sections shall conform to the physical specifications of BS/equivalent international standards. All other miscellaneous secondary members shall have minimum yield strength of 250 MPa.

21.3 DESCRIPTION

21.3.1 PRIMARY MEMBERS:

Primary structural framing shall include the transverse rigid frames, columns, corner columns, end wall wind columns and crane gantry girders and Frames at Door openings.

21.3.2 SECONDARY MEMBERS:

Secondary structural framing shall include the purlins, girts, eave struts, wind bracing, flange bracing, base angles, clips, flashings and other miscellaneous structural parts. Suitable wind bracings sag rods to be reckoned while designing the structure.

21.3.3 PURLINS, GIRTS,CLIPS:

Purlins, girts and clips should be of Pre Galvanised steel of 345 Mpa having a coating thickness of 275 gms/sq. M inclusive of both sides.

21.3.4 ROOF AND WALL SHEETING

Factory assembled 50mm thick puff (density 40kg/cu.m. +2 Kg/cu m as per BS/equivalent International Standards) sandwiched panels shall be provided. These panels shall be made of puff insulation sandwiched between two high tensile steel sheets each of 0.5 mm thickness. The material of sheets shall confirm to ASTM 792 M Grade 345 with minimum yield strength of 345 Mpa . The steel sheets shall be provided with hot dip coating of Zinc aluminium alloy (approximately 55% Al, 43.5% Zn and 1.5 % silicon) .Total mass of zinc aluminium alloy coating shall be minimum 200 gm/Sq. m inclusive of both sides. The tolerance of base metal thickness (BMT) of steel sheet shall be as per BS/equivalent International Standards. After hot dip coating of Zinc aluminium alloy, the sheet shall be provided with steel primer and silicon modified polyester (SMP) paint. The total thickness of primer and paint shall be 40 microns inclusive of both sides (TCT) comprising of 20 microns of SMP paint on top surface and 10 microns of backer coat (polyester coat) on back surface over 5 microns thick primer each on both surfaces with inorganic pigments coated free from heavy metals. Painting shall conform to BS/equivalent International Standards. In case SMP paint is not available, Super Durable Polyester paint (SDP) can also be used by the bidder without cost implication to POWERGRID.

21.3.5 Wall Panels

Wall panel material specifications shall be same as roof panels.
21.3.6 **SHEETING FASTENERS:**

Standard fasteners shall be self-tapping zinc plated metal screws with EPDM bonded zinc plated washers. All screws shall be colour coated to match roof and wall sheeting.

21.3.7 **SEALER:**

This is to be applied at all side laps and end laps of roof panels and around self-flashing windows. Sealer shall be pressure sensitive elastomeric Butyl tapes. The sealer shall be non-asphaltic, non-shrinking and non-toxic and shall be superior adhesive metals, plastics and painted at temperatures from 51°C to +104°C.

21.3.8 **CLOSURES:**

Solid or closed cell closures matching the profiles of the panel shall be installed along the eaves, rake and other locations specified on drawings. Material shall be minimum 26 gauge thick conforming to the physical specification of sheeting material.

21.3.9 **FLASHING AND TRIM:**

Flashing and / or trim shall be furnished at the rake, corners, eaves, and framed openings and wherever necessary to provide weather tightness and finished appearance. Colour shall be matching with the colour of wall. Material shall be 26 gauge thick conforming to the physical specifications of sheeting.

21.3.10 **WALL LIGHTS:**

For day lighting purpose of GIS hall, minimum 2 mm thick approved translucent polycarbonate sheet shall be provided for wall lighting in addition to windows for at least 10% of wall area on upper portion of both long walls. The polycarbonate sheet shall be fixed with necessary EPDM, rubber gasket, Silicon Sealant, cold forged fastener, aluminum profile etc. including MS supporting structural steel (conforming to relevant BS/equivalent International Standards) frame to ensure water tight arrangement.

21.3.11 **GUTTERS AND DOWN SPOUTS:**

Gutters and downspouts shall be adequately designed to ensure proper roof drainage system. Material shall be minimum 26 gauge thick conforming to physical specification of sheeting with matching colour.

21.3.12 **PAINTING OF BUILT UP STEEL FRAMES, CRANE GANTRY GIRDERS, FRAMES AT DOOR OPENINGS, WALK WAY STEEL AND LADDER:**

The built up frame, Crane gantry girders, frames for door openings and steel for walk way shall be applied with a priming coat of standard steel primer followed by one coat coating of epoxy paint and final coating of PU (Minimum 100 Micron). The steel work for aforesaid members shall be provided with suitable treatment of shot blasting before application of steel primer. The steel material of ladder shall be galvanized.

21.3.13 **COLOUR SCHEME:**
Colour Scheme matching with local aesthetic and best industry practices shall be submitted by vendors for approval of POWERGRID. Three alternatives of coloured isometric views with colour codes shall be submitted for approval. The monotony of external colour of sheet shall be avoided by providing vertical bands of different coloured sheet. The colour of roof sheet shall be light coloured to minimize heat absorption. External and internal masonry walls shall be painted with suitable colour matching with colour of steel sheet.

21.4 CONNECTIONS:

21.4.1 SITE CONNECTIONS

a) All primary bolted connections shall be provided with galvanized high strength bolts, washers, nuts conforming to specifications of relevant standard.

b) All secondary bolted connections shall be furnished with bolts, nuts, washers conforming to the specifications of grade 4.6 of relevant standard or ASTM-A307.

21.4.2 SHOP CONNECTIONS

All shop connections shall be welded with appropriate arc welding process and welding shall be in accordance with relevant standard, AWSD 1.1. as appropriate. The Webs should be welded on to the flanges at both the faces at top and bottom for columns, beams and crane girders. Weld material should have strength more than the parent metal.

21.4.3 ROOF & WALL BRACINGS

Roof and wall bracings shall have minimum yield strength of 250 Mpa and shall conform to the specifications of relevant standard.

21.5 INTERNAL FINISH SCHEDULE

The finishing schedule is given in subsequent clauses and table-1. Areas not specified in finish schedule shall be provided with vitrified tile flooring, and Premium Acrylic emulsion paint oil bound washable distemper over two mm thick putty. Paints used in the work shall be of best quality specified in relevant standard.

21.5.1 FLOORING

Flooring in various rooms of control room building and GIS hall shall be as per detailed schedule given in Table -1.

21.5.2 WALLS

All walls of control room building shall be non-load bearing walls. Min. thickness of walls shall be 230 mm (one brick) with 1:6 cement sand mortar. Partition walls (115mm thick) in toilets and pantry can be half brick walls with 1:4 cement sand mortar and two nos. 6mm dia MS bars at every third course.

In GIS building and the attached panel/relay/AHU room, 230mm thick brick wall shall be provided up to a height of 150 mm above false ceiling level of panel/relay room. 50mm thick puff sandwiched panels as described above shall be provided above brick wall.
21.5.3 ROOF

(A) GIS Building and Control Room (if steel structure)

Roofing Panel: 50mm thick puff (density 40kg/cu.m.) sandwiched panels shall be provided as described in previous clauses.

21.6 CABLE TRENCH IN GIS HALL

All cable trenches in GIS hall shall be covered with minimum 6mm thick steel chequered plate with suitable stiffeners. Chequered plate and stiffeners shall be painted with two or more coats of Epoxy paint as per relevant standards.

21.7 EXTERNAL PLASTER AND PAINTING

External plaster 18mm thick shall be of 1:6 cement sand plaster in two layers. External surface of the control room building and GIS building (brick wall portion) shall be painted with Premium acrylic smooth exterior paint with silicon additives over and including priming coat of exterior primer as per relevant standards.

21.8 INTERNAL FINISH SCHEDULE

Internal finish Schedule for control room building and GIS hall is given in Table - 1 below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>LOCATION</th>
<th>FLOORING &amp; SKIRTING 150MM HIGH</th>
<th>WALL (INTERNAL)</th>
<th>CEILING</th>
<th>DOOR, WINDOWS &amp; VENTILATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control Room</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False ceiling and White wash above False Ceiling</td>
<td>Windows shall be of 10mm thick toughened glass by using suitable patch fittings/spider fittings. The glass shall extend horizontally from column to column and vertically from sill level of 0.75 m to bottom of lintel/roof beam. All doors shall be glazed powder coated aluminium doors with 5.5 mm Thk. Glazing.</td>
</tr>
<tr>
<td>2.</td>
<td>Conference</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk.</td>
</tr>
<tr>
<td>S.No.</td>
<td>LOCATION</td>
<td>FLOORING &amp; SKIRTING 150MM HIGH</td>
<td>WALL (INTERNAL)</td>
<td>CEILING</td>
<td>DOOR, WINDOWS &amp; VENTILATOR</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>-------------------------------</td>
<td>----------------</td>
<td>---------</td>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>thick)</td>
<td></td>
<td>Glazing.</td>
</tr>
<tr>
<td>3.</td>
<td>In-charge Room</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>4</td>
<td>Other Office Rooms</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>5</td>
<td>Electronics Test Lab.</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>6</td>
<td>ACDB &amp; DCDB Room</td>
<td>62mm thick cement concrete flooring with metallic hardener topping</td>
<td>Oil bound washable distemper on smooth surface applied with plaster of paris putty as per relevant standards</td>
<td>Oil bound washable distemper on smooth surface applied with plaster of paris putty</td>
<td>Steel door 45mm thick double sheet 18 gauge MS steel suitably reinforced and filled with mineral wool. Windows/ventilator shall be of powder coated aluminium with 4mm glazing.</td>
</tr>
<tr>
<td>7</td>
<td>Battery room</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on</td>
<td>False ceiling and White wash above</td>
<td>Steel door 45mm thick double sheet 18 gauge MS steel suitably reinforced</td>
</tr>
<tr>
<td>S.No.</td>
<td>LOCATION</td>
<td>FLOORING &amp; SKIRTING 150MM HIGH</td>
<td>WALL (INTERNAL)</td>
<td>CEILING</td>
<td>DOOR, WINDOWS &amp; VENTILATOR</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>--------------------------------</td>
<td>-----------------</td>
<td>---------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False Ceiling</td>
<td>and filled with mineral wool. Windows/ventilator shall be of powder coated aluminium with 4mm glazing.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Lobby</td>
<td>18mm thick granite flooring</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False Ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>9.</td>
<td>Corridor</td>
<td>Vitrified tiles size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False Ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>10.</td>
<td>Portico</td>
<td>18mm thick granite flooring</td>
<td>Granite cladding</td>
<td>Acrylic emulsion paint over a coat of cement primer on smooth surface applied with readymade putty 1 mm thick as per relevant standards</td>
<td>All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>11.</td>
<td>Toilet</td>
<td>Ceramic tiles</td>
<td>DADO glazed tile 2100mm high, oil bound washable</td>
<td>Acrylic emulsion paint over a coat of cement primer on</td>
<td>Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door</td>
</tr>
<tr>
<td>S.No.</td>
<td>LOCATION</td>
<td>FLOORING &amp; SKIRTING 150MM HIGH</td>
<td>WALL (INTERNAL)</td>
<td>CEILING</td>
<td>DOOR, WINDOWS &amp; VENTILATOR</td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
<td>---------------------------------</td>
<td>----------------------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>distemper above DADO</td>
<td>smooth surface applied with ready made putty 1 mm thick as per relevant standards</td>
<td>shutters made of pre-laminated particle board (with powder coated aluminium frame)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Janitor room</td>
<td>Ceramic tiles</td>
<td>DADO glazed tile 2100mm high, oil bound washable distemper above DADO</td>
<td>Acrylic emulsion paint over a coat of cement primer on smooth surface applied with ready made putty 1 mm thick as per relevant standards</td>
<td>Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters made of pre-laminated particle board with powder coated aluminium frame</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>GIS Hall</td>
<td>62mm thick cement concrete flooring with metallic hardener topping (DSR item code 11.5). Two coats of PU coating over the metallic hardener shall be provided. The final coat of PU shall be applied after installation of equipment. Total thickness of PU coats shall be minimum 300 microns.</td>
<td>Premium Acrylic emulsion paint having Volatile Organic Compound (VOC) content less than 50gms per litre of approved brand and manufacturer on smooth surface applied with plaster of paris (2 mm thick) over approved primer coat.</td>
<td>In case of RCC roof, ceiling shall be finished with Premium Acrylic emulsion paint having Volatile Organic Compound (VOC) content less than 50gms per litre of approved brand and manufacturer over approved primer coat</td>
<td>Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters with powder coated aluminium frame.</td>
</tr>
<tr>
<td>S.No.</td>
<td>LOCATION</td>
<td>FLOORING &amp; SKIRTING 150MM HIGH</td>
<td>WALL (INTERNAL)</td>
<td>CEILING</td>
<td>DOOR, WINDOWS &amp; VENTILATOR</td>
</tr>
<tr>
<td>------</td>
<td>------------------------</td>
<td>---------------------------------</td>
<td>-----------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>14</td>
<td>Panel/Relay Room</td>
<td>Vitrified tiles 8mm thick size 600 x 600mm</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>False ceiling and White wash above False Ceiling</td>
<td>Windows shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be glazed powder coated aluminium doors with 5.5mm thk. Glazing.</td>
</tr>
<tr>
<td>15</td>
<td>AHU Room</td>
<td>62mm thick cement concrete flooring with metallic hardener topping</td>
<td>Premium Acrylic emulsion paint on smooth surface applied with plaster of paris (2 mm thick)</td>
<td>Acrylic emulsion paint over a coat of cement primer on smooth surface applied with readymade putty 1 mm thick as per relevant standards</td>
<td>Windows/ ventilator shall be of powder coated aluminium with 5.5mm thick glazing. All doors shall be flush door shutters with powder coated aluminium frame.</td>
</tr>
</tbody>
</table>

21.9 Staircase shall be provided with stainless steel railing and 18mm thick granite slab in risers and treads.

21.10 **DOORS AND WINDOWS**

The details of doors and windows of the control room building shall be as per finish schedule Table-1 conforming to relevant BS/equivalent International Standards. Rolling steel shutters shall be provided as per layout and requirement of buildings. Main entrance door to control room building shall be made of powder coated aluminium frame with 5.5 mm thick glazing.

21.11 **PARTITION**

Partitions, if required, shall be made of powder coated aluminium frame provided with 5.5 mm thick clear glass or pre-laminated board depending upon the location of partition.

21.12 **FALSE CEILING**

Fifteen millimeter thick densified regular edged eco-friendly light weight calcium silicate false ceiling as per relevant standards shall be provided in the areas specified in Finish Schedule.

21.13 **PLUMBING & SANITATION**
(i) All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.

(ii) PVC “SYNTEX” or equivalent make Roof water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided. Minimum 2 Nos 1500 liter capacity shall be provided.

(iii) Galvanized MS pipe of medium class conforming to relevant standards shall be used for internal & external piping work for potable water supply.

(iv) Sand CI pipes with lead joints conforming to relevant standards shall be used for sanitary works above ground level and RCC pipe shall be used for works below ground.

(v) Each toilet shall have the following minimum fittings.

(a) WC (Western type) 390 mm high with toilet paper roll holder and all fittings in toilets attached to conference and sub-station in charge office.

and

WC (Indian Type) Orissa Pattern (580 x 440 mm) with all fittings shall be provided in common toilets.

(b) Urinal (430 x 260 x 350 mm size) with all fittings.

(c) Wash basin (550 x 400 mm) with all fittings.

(d) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing

(e) CP brass towel rail (600 x 20 mm) with C.P. brass brackets

(f) CP Soap holder and CP liquid soap dispenser.

(g) All urinals and washbasins shall be provided with built in sensors.

(vi) Water cooler for drinking water with adequate water storage facility shall be provided and located near control room and not near toilet block.

(viii) 1 no. stainless steel kitchen sink with Drain board (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.

(ix) All fittings, fastener, grating shall be chromium plated.

(x) All sanitary fixtures and fittings shall be of approved quality and type manufactured by well-known manufacturers. All items brought to site must bear identification marks of the type of the Manufacturer.

(xi) Stoneware pipes may be used for soil, waste and drain pipes in the areas not subjected to heavy loads otherwise Heavy duty cast iron pipes may be used.

(xii) Contractor shall provide septic tank and soak pit of adequate capacity to treat the sewage / sullage from the building.

(xiii) Contractor shall implement all other jobs required to complete and commission the building.

22. RESIDENTIAL AND NON RESIDENTIAL BUILDINGS

All buildings shall be constructed as RCC Framed buildings. The architectural features shall match with local architecture. For preparation of architectural drawings of these buildings, the contractor shall depute local Architect of repute who must be well aware of local bye laws and statutory clearances required for residential and guest
house/field hostel/Transit camp building from Nepal Authority. The buildings shall be
designed for loads as applicable in accordance to relevant standards. The plumbing
and sanitary works including overhead water tanks placed on terrace and for each
building shall also be deemed to be included in the civil works of building.
Construction of man holes/chambers, connection of internal plumbing and sanitary
system with external sewerage and water supply system shall be considered as a part
of civil works of buildings. These works will not be measured and paid separately.

The details and approximate size of various buildings are as below:

(a) Transit Camp: One number of size 15 m X 14 m (Double Storeyed with each
floor of 15 m X 14 m).
(b) D-Type Quarter: One Number with size 15 m x 14 m-Single Storeyed.
(c) C-Type Quarters: Four Numbers: One Block of four quarters having two
quarters on ground floor and two quarters on first floor. Block will have an
area of about 12 m x 25 m on each floor.
(d) B-Type Quarters: Four Numbers: One Block of four quarters having two
quarters on ground floor and two quarters on first floor. Block will have an
area of about 10 m x 25 m on each floor.

The area for above buildings has been indicated as tentative. The Contractor shall
adopt the suitable size to accommodate various rooms and services for each type of
building. The size of various rooms shall be in accordance to local laws.

The finish schedule has been tabulated as below:

<table>
<thead>
<tr>
<th>Schedule of Finishes for Quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Typical Flat</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Room Name</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Attached Toilet/Bed Room Toilet</td>
</tr>
<tr>
<td>Passage</td>
</tr>
<tr>
<td>Cupboard</td>
</tr>
<tr>
<td>Staircase</td>
</tr>
<tr>
<td>Car Parking</td>
</tr>
</tbody>
</table>

**Schedule of Finishes for Transit Camp**

<table>
<thead>
<tr>
<th>Floor</th>
<th>Room Name</th>
<th>Flooring</th>
<th>Walls</th>
<th>Ceiling</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porch</td>
<td>60mm thk. Flexi Paver Blocks</td>
<td>Plastered &amp; Painted with Exterior Paint</td>
<td>Plastered &amp; Painted with OBD Over 2mm POP Finish</td>
<td>Vitrified Tiles Skirting of 150mm high to be Provided</td>
<td></td>
</tr>
<tr>
<td>Drawing &amp; Dining</td>
<td>Polished Vitrified Tiles 0.6x0.6M</td>
<td>Plastered &amp; Painted Plastic Emulsion Paint over 2mm POP Finish</td>
<td>Minera Fibre False Ceiling POP Cornice &amp; Moulding Painted with Plastic Emulsion Paint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby</td>
<td>DO</td>
<td>DO</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td>DO</td>
<td>DO</td>
<td>DO</td>
<td>Ceramic Tiles from Floor Level to 0.6M Above Kitchen Platform</td>
<td></td>
</tr>
<tr>
<td>VIP Room &amp; Lounge</td>
<td>DO</td>
<td>DO</td>
<td>DO</td>
<td>POP Cornice &amp; Moulding shall be Provided for</td>
<td></td>
</tr>
<tr>
<td>Room Type</td>
<td>Floor Material Description</td>
<td>Ceiling Material Description</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>------------------------------</td>
<td>--------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attached Toilet of VIP Room</td>
<td>Vitrified Tiles (Antiskid) 0.6x0.6M</td>
<td>Ceramic Tiles 0.3x0.45M (Minimum size) up to Ceiling</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dormitory</td>
<td>22mm Thk. Terrazzo Tiles Light shade</td>
<td>Plastered &amp; Painted OBD Over 2mm POP Finish</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dormitory Toilet/Bath</td>
<td>Antiskid Ceramic Glazed 1st Quality Floor Tiles-0.3x0.3M</td>
<td>Ceramic Tiles 0.2x0.3M up to 2.1M</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staircase</td>
<td>18mm Thk. Udaipur Green Marble Stone</td>
<td>Plastered &amp; Painted OBD Over 2mm POP Finish</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed Rooms</td>
<td>Polished Vitrified Tiles 0.6mx0.6m</td>
<td>Plastered &amp; Painted with Plastic Emulsion Paint Over 2mm POP Finish</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attached Toilets</td>
<td>Antiskid Ceramic Glazed 1st Quality Floor Tiles-0.3x0.3M</td>
<td>Ceramic Tiles 0.2x0.3M up to 2.1M</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Care Taker Room</td>
<td>Vitrified Tiles With Light Shade</td>
<td>Plastered &amp; Painted OBD Over 2mm POP Finish</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Toilet</td>
<td>Antiskid Ceramic Glazed 1st Quality Floor Tiles-0.3x0.3M</td>
<td>Ceramic Tiles 0.2x0.3M up to 2.1M</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store</td>
<td>Vitrified Tiles With Light Shade</td>
<td>Plastered &amp; Painted OBD</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balconies</td>
<td>Antiskid Vitrified Tiles Light Shade</td>
<td>Plastered &amp; Painted with Exterior Paint</td>
<td>DO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrace</td>
<td>Brick Bat Coba Water Proofing</td>
<td>Plastered &amp; Painted with Exterior Paint</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
22.1 FURNISHING OF TOWNSHIP BUILDINGS, GIS AND CONTROL ROOM

22.1.1 IN UDIPUR SUB-STATION
Furniture which are going to be supplied in township buildings, GIS and control room shall be of standard quality. Wooden furniture shall be made from maple, teak, oak, shisham or sal and steel furniture shall be made from high quality steel or approved from employer’s engineers.

The bidder shall supply delivery and execution of:

- **Sofa Set**: Quantity=8 Nos, standard high quality, 5 seater sofa set.
- **King’s size Bed**: Quantity=3 Nos, wooden box type bed with standard quality and size 5’ by 6.5’ including good quality memory foam mattress.
- **Queen’s size Bed**: Quantity=9 Nos, wooden box type bed with standard quality and size 4’ by 6’ including good quality memory foam mattress.
- **Normal Single Bed**: Quantity=36 Nos, wooden box type bed with standard quality and size 3’ by 6’ including good quality memory foam mattress.
- **Night Stand**: Quantity= 51 Nos, Wooden night stand of standard size having a drawer and open storage underneath the drawer.
- **Dining Table**: Quantity=10 sets, made from above mentioned wood, minimum size 3’ by 6’, capacity of minimum 5 seater. Wooden chairs of standard quality with cushion.
- **Glass Tea Table (standard)**: Quantity=5 Nos. Body made from wood and top flat surface from high quality glass; minimum size about 47” by 25” by 17”.
- **Wooden Tea Table**: Quantity=8 Nos. Made from high quality wood (mentioned above); minimum size about 47” by 25” by 17”.
- **Wooden Normal Chair**: Quantity= 26 Nos., wooden chair of standard size with cushion.
- **Book Shelves**: Quantity= 4 Nos., made from laminated MDF and particle board or equivalent with tempered glasses, four shelves; two adjustable and two fixed, two framed glass doors.
- **Wooden Wardrobe**: Quantity=29 Nos., wooden wardrobe of height about 72”. It shall have minimum two doors.
- **Dressing Table**: Quantity=7 Nos., wooden dressing table of height about 72”.
- **Study Table and chair**: Quantity= 11 Nos., wooden study table and chair of standard size.
- **Three seater lounge Chair**: Quantity= 4 Nos., made from stainless steel, aluminum alloy with silver painting.
- **L-Type Executive Table**: Quantity= 1 No., Wooden L-shaped desk with right/left return shall combine an executive desk and computer desk into one impressive package. Desk shall measure about 69” x 28” while the return shall measure about 48” by 22”.
- **Executive Chair**: Quantity= 1 No., revolving chair-adjustable lumber support and instant seat height adjustment. Heavy duty plastic 5-prong base Height/width adjustable arms with soft/ durable urethane pads. Minimum dimensions: 30” W x 28” D and 42” to 44” H. Best quality leader cushioning, Back Rest, etc.
- **Office Table (standard)**: Quantity= 1 No., Table size 6’ by 3’ made of wood, 3 drawers (with locks) on one side and drawer and cabinet on other side, Side rack with keyboard tray. Polished as per instruction and approved color by Employer’s Engineer in charge.
- **Revolving Chair**: Quantity= 1 No., revolving chair-adjustable lumber support and instant seat height adjustment. Heavy duty plastic 5-prong base Height/width adjustable arms with soft/ durable urethane pads. Minimum
dimensions: 30" W x 28" D and 42" to 44" H. Best quality leader cushioning, Back Rest, etc.

- **Office Table and Chair (normal):** Quantity= 12 sets, made from wood, having straight configuration, minimum dimension of 2 ft. 5 in. by 3 ft. 11 in., including storage. Adjustable seat height, revolving mechanism, back tilt, arm rest, mild steel frame, and fabric upholstered seat material, of standard size.

- **Visitor Chair:** Quantity= 4 Nos. Metal Frame, upholstery cushion. Minimum dimension W x H: 56 cm x 91 cm.

- **Conference Table with Chairs:** Quantity= 1 set; It shall have minimum capacity of 8 seats. Made from high quality wood and MDF top with Membrane foil coated with layer of polyurethane or equivalent for better scratch and wear resistance. It shall have good quality of chairs (minimum 8 Nos.) as mentioned in item “Revolving Chair”.

- **32" smart TV:** Quantity= 3 Nos., Smart TV shall be Full HD LED Smart TV with 32” measured diagonally. It shall have built-in Wi-Fi, resolution of 1920 x 1080, Wi-Fi direct, Mobile to TV-mirroring, Inputs and outputs (HDMI, USB, and Ethernet).

- **Curtain:** High quality curtain shall be provided in all windows of staff quarters, GIS and Control Room Buildings and Transit Camps of Udipur Sub-Station.

**Note:** Sample of all above shall be submitted to the employer for approval.

### 22.1.2 IN BHARATPUR SUB-STATION

Furniture which are going to be supplied in township buildings, GIS and control room shall be of standard quality. Wooden furniture shall be made from maple, teak, oak, shisham or sal and steel furniture shall be made from high quality steel or approved from employer’s engineers.

The contractor shall supply delivery and execution of:

- **Sofa Set:** Quantity=7 Nos., standard, high quality, 5 seater sofa set.
- **King’s size Bed:** Quantity=2 Nos., wooden box type bed with standard quality and size 5’ by 6.5’ including good quality memory foam mattress.
- **Queen’s size Bed:** Quantity=8 Nos., wooden box type bed with standard quality and size 4’ by 6’ including good quality memory foam mattress.
- **Normal Single Bed:** Quantity=13 Nos., wooden box type bed with standard quality and size 3’ by 6’ including good quality memory foam mattress.
- **Night Stand:** Quantity= 25 Nos., Wooden night stand of standard size having a drawer and open storage underneath the drawer.
- **Dining Table:** Quantity=5 sets, made from above mentioned wood, minimum size 3’ by 6’, capacity of minimum 5 seater. Wooden chairs of standard quality with cushion.
- **Glass Tea Table (standard):** Quantity= 4 Nos. Body made from wood and top flat surface from high quality glass; minimum size about 47” by 25” by 17”.
- **Wooden Tea Table:** Quantity= 4 Nos. Made from high quality wood (mentioned above); minimum size about 47” by 25” by 17”.
- **Wooden Normal Chair:** Quantity= 14 Nos., wooden chair of standard size with cushion.
- **Book Shelves:** Quantity= 3 Nos., made from laminated MDF and particle board or equivalent with tempered glasses, four shelves; two adjustable and two fixed, two framed glass doors.
- **Wooden Wardrobe:** Quantity=17 Nos., wooden wardrobe of height about 72”. It shall have minimum two doors.
- **Dressing Table:** Quantity= 6 Nos., wooden dressing table of height about 72”.

---

ICB/PMD/MCTLP/017/18-01  
Volume-II, Chapter 14- Civil Works  
Marsyangdi Corridor 220 kV Transmission Line Project  
Procurement of plant  
Single-Stage, Two-Envelope  
Page 51 of 72
- **Study Table and chair**: Quantity= 6 Nos., wooden study table and chair of standard size.
- **Three seater lounge Chair**: Quantity= 4 Nos., made from stainless steel, aluminum alloy with silver painting.
- **L-Type Executive Table**: Quantity= 1 No., Wooden L-shaped desk with right/left return shall combine an executive desk and computer desk into one impressive package. Desk shall measure about 69" x 28" while the return shall measure about 48" by 22".
- **Executive Chair**: Quantity= 1 No., revolving chair-adjustable lumber support and instant seat height adjustment. Heavy duty plastic 5-prong base Height/width adjustable arms with soft/ durable urethane pads. Minimum dimensions: 30" W x 28" D and 42" to 44" H. Best quality leader cushioning, Back Rest, etc.
- **Office Table (standard)**: Quantity= 1 No., Table size 6’ by 3’ made of wood, 3 drawers (with locks) on one side and drawer and cabinet on other side, Side rack with keyboard tray. Polished as per instruction and approved color by Employer’s Engineer in charge.
- **Revolving Chair**: Quantity= 1 No., revolving chair-adjustable lumber support and instant seat height adjustment. Heavy duty plastic 5-prong base Height/width adjustable arms with soft/ durable urethane pads. Minimum dimensions: 30” W x 28” D and 42” to 44” H. Best quality leader cushioning, Back Rest, etc.
- **Office Table and Chair (normal)**: Quantity= 12 sets, made from wood, having straight configuration, minimum dimension of 2 ft. 5 in. by 3 ft. 11 in., including storage. Adjustable seat height, revolving mechanism, back tilt, arm rest, mild steel frame, and fabric upholstered seat material, of standard size.
- **Visitor Chair**: Quantity= 4 Nos. Metal Frame, upholstery cushion. Minimum dimension W x H; 56 cm x 91 cm.
- **Conference Table with Chairs**: Quantity= 1 set; It shall have minimum capacity of 8 seats. Made from high quality wood and MDF top with Membrane foil coated with layer of polyurethane or equivalent for better scratch and wear resistance. Shall have quality of chairs (chairs-minimum 8 Nos.) as mentioned in item “Revolving Chair”.
- **32” smart TV**: Quantity= 2 Nos., Smart TV shall be Full HD LED Smart TV with 32” measured diagonally. It shall have built-in Wi-Fi, resolution of 1920 x 1080, Wi-Fi direct, Mobile to TV-mirroring, Inputs and outputs (HDMI, USB, and Ethernet).
- **Curtain**: High quality curtain shall be provided in all windows of staff quarters, GIS and Control Room Buildings and Transit Camps of Bharatpur Sub-Stations.

**Note:** Sample of all above shall be submitted to the employer for approval.

### 22.2 VEHICLE INSPECTION RAMP

RCC vehicle inspection ramp shall be constructed in Udipur. It shall be designed with inclined part followed by horizontal portion for inspection of vehicle. The horizontal portion shall be designed in such a way that full size pick-up van/car/truck can be inspected efficiently. The height of the ramp shall be about 2m from the ground. Site preparation, excavation, back fill and disposal of surplus earth and foundation/RCC Construction shall be done as elaborated in relevant specification, clause no. 4 and 11 of civil works respectively. The quantity for this item is included in BPS, Schedule No 4(a), Part-C, Civil Works and shall not be paid separately. The item shall be measured and paid on cubic meter basis.
22.3 **VOLLEY BALL COURT**
Standard size (18 m by 9 m) volley ball court shall be constructed in Udipur substation. Site preparation, excavation, backfill and disposal of surplus earth shall be done as per relevant specification, clause No. 4 of Civil Works. Dry boulder packing, compaction and levelling (Stone soling) shall be done as per approval of Employer’s Engineer. 7.5 cm PCC (1:2:4) work shall be constructed for volley ball court. Painting/marking dimensions shall be done with specialist sports court paint and as per standard dimensions. Two standard size cast iron poles shall also be installed as per approval of Employer’s Engineer. The item shall be measured and paid on lump sum basis.

22.4 **BADMINTON COURT**
Standard size (13.4 m by 6.1 m) badminton court shall be constructed in Udipur substation. Site preparation, excavation, backfill and disposal of surplus earth shall be done as per relevant specification, clause No. 4 of Civil Works. Dry boulder packing, compaction and levelling (Stone soling) shall be done as per approval of Employer’s Engineer. 7.5 cm PCC (1:2:4) work shall be constructed for badminton court. Painting/marking dimensions shall be done with specialist sports court paint and as per standard dimensions. Two standard size cast iron poles shall also be installed as per approval of Employer’s Engineer. The item shall be measured and paid on lump sum basis.

23. **COMMUNITY HALL AND GYM HALL**

**GENERAL**
The scope includes design, engineering and construction, including anti-termite treatment, plinth protection, DPC, peripheral drains, electrification etc. The hall shall be essentially single storied steel framed building with sloping roof of steel truss and 0.63 mm thick CGI roof sheet. The internal electrification shall be designed in accordance with the requirements as specified in relevant section of the technical specification.

**AREA REQUIREMENTS**

The approximate size of building is 20m x 10m x 4m for Community Hall and 8m x 5m x 4m for Gym hall.

**DESIGN CRITERIA**
The building shall be designed:
1. To the requirements of the relevant/ British standards/ equivalent International standards quoted therein, and as specified in this specification.
2. For the specified climatic and loading conditions.
3. With a functional and economical space arrangement.
4. To be aesthetically pleasing.
5. With, wherever required, fire retarding materials for walls, doors etc., which would prevent supporting or spreading of fire and shall be decided by the bidder.
6. Suitable expansion joints, wherever required as per codal provisions.
7. All the members of the building frame shall be designed for the worst combination if loads as per relevant International standards/British standards.
8. Permissible stresses for different load combinations shall be taken as per relevant International standards/ British Standards.
9. Seismic analysis of the building for Earthquake forces shall be carried out as per relevant international standards/British Standards.
DESIGN LOADS
1. Building structure shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, wind loads, seismic loads, etc. Any other incidental load, if anticipated, shall be duly accounted for in the design, and shall be clearly mentioned by the bidder.
2. Dead loads shall include the weight of the structures complete with finishes, fixtures and partitions, and shall be taken as per relevant international standards/British Standards.
3. Super-imposed loads in different area shall include line loads, loads from stores materials etc.
4. Wind loads shall be calculated as per relevant international standards/British Standards. The factors affecting the wind speed shall be taken based on the site conditions.
5. Earthquake loads shall be calculated as per relevant international standards/British Standards.
6. Wind forces and seismic forces shall not consider simultaneously.
7. All the load combinations to create worst combinations of loads shall be as per relevant international standards/British Standards.

FLOORS AND WALLS
The floor shall be constructed with 52 mm thick cement concrete finished with metallic hardener topping. 150 mm thick base plain cement concrete, 100mm thick compacted local sand filling and 200mm thick hard core of stone ballast with interstices filled with local sand shall be laid below cement concrete flooring top. The earth filling below floor shall be well rammed.
All walls shall be non-load bearing in brickwork as per specification. Minimum thickness of walls shall be 230 mm with 1:6 cement sand mortar.

FALSE CEILING
Providing and fixing seamless ceiling with Gypsum Board of 12 mm thick fixed to the underside of GI frame work. The GI is fixed to the roof with metal expansion fastener. It shall be done as per relevant international standards/British Standards.

PLASTERING
External surfaces of building shall have 18 mm thick plaster in two layers, with the under layer 12mm thick 1:5 cement sand (coarse) plaster and the top layer 6 mm thick 1:6 cement sand (coarse) plaster. Inside wall surfaces shall have 12/15 mm thick 1:6 cement sand (coarse) plaster. Rough surfaces shall have 15mm and smooth surface shall have 12 mm thick cement sand plaster.

PANTING
External surfaces of the building shall be painted with acrylic exterior flat paint as per approval of NEA/Consultant.
Internal surfaces of the building shall be painted with oil bound washable distemper on masonry portion.

PLINTH PROTECTION
750 mm wide plinth protection all-around the building shall be provided. Plinth protection shall comprise of 50 mm thick PCC(1:2:4) laid over 75 mm thick well compacted stone aggregates with interstices filled with local sand including smooth finishing top.
STEEL FRAME
All hot rolled sections (I-section, C-section, etc.) shall conform to the physical specification of BS/equivalent international standards. All sections shall have minimum yield strength of 250 MPa or as per design.

DOORS AND WINDOWS
Doors and Windows shall be constructed and installed/fitted as per approval of Employer’s Engineer.

BUILDING STORM WATER DRAINAGE
1. The building design shall provide for the collection of storm water from the roof. This water shall be drained to the main drainage system of the Sub-Station.
2. Cast iron rainwater downcomer piped conforming to relevant international standard/British Standards with water tight lead joints or medium class galvanized mild steel pipes conform to relevant international standards/British Standards shall be provided to drain off the rain water from the roofs. These pipes shall be suitably concealed with masonry work or cement concrete or cladding material.
3. Suitable arrangements for draining out water collected from equipment blow downs, leakages, floor washing, firefighting etc. shall be provided, if found necessary.

DETAILS OF ROOF
Roof of the Building shall be sloping type made of steel tubular truss and 0.63 mm thick CGI sheet. All necessary hooks, J bolts, washers and nuts etc. required to fix CGI sheet with truss shall be provided. The roof shall be leak proof and holes shall be properly sealed. The truss may be fixed with steel tie beam and column with MS plate and bolts properly. Suitable MS gutter/truffal along the face of roof sheet shall be provided to collect rain water from roof to finally discharge into rain water pipes. Rafters, struts, purlin, cleat, base plate, tie beam etc. required for truss shall be as per relevant British codes/ equivalent International Standards. All steel work shall be provided with a priming coat of standard steel primer followed by one coat of epoxy paint and final coating of PU (Minimum 100 micron). The steel work for aforesaid members shall be provided with suitable treatment of shot blasting before application of steel primer.

ELECTRIFICATION
All electrification shall be executed as per details specified elsewhere in the technical specification. All details shall be as per relevant British standard codes (B S Codes)/ equivalent International Standards.

MEASUREMENT
The building shall be measured and paid on Square meter area basis. All the items necessary to complete the building shall be deemed to be included in unit rate of building.

23.1 EQUIPMENT TO BE SUPPLIED IN UDIPUR GYM HALL
Equipment which are going to be supplied in Udipur Gym Hall shall have at least or/and equivalent following specifications:

1. Six Pack Care: Quantity= 2 Nos.
   Contractor shall provide 2 numbers of Six Pack care equipment. It shall target upper, middle, lower abs, waistline as well as obliques, with cushioned and
massaging back support, giving a more comfortable use. It shall have more than 180 degree range of motions, offer adjustable resistance levels to suit all fitness levels and allow 6 different types of workout.

2. **Commercial Motorized Treadmill: Quantity= 2 Nos.**
   AC Motor: 4.0HP, Speed Range: 1-18km/h, Incline Range: 0-18%, Double safety protection functions with both emergency stop and stop, PU handrail, multi-windows LED display, preset multiple intelligent running programs and user-defined modes, High-power Hi-Fi system; MP3 audio input, Smart fan, professional and simple user operation interface; quick buttons for speed, incline and program; humanity management of system setting, multilayer shock absorption system.

3. **Fitness Upright Exercise Bike: Quantity= 1 No.**
   Weight Supported at least 135 kg, LCD display, graphic of at least full color 7 inch, deluxe racing handlebars, evaluates fit test, shall have goal workouts (time, distance, calories, distance climbed, pace etc.), integrated reading rack and smartphone accessory tray, lifepulse digital heart rate monitoring with DPS (Digital Signal Processing), comfort curve plus seat, shall have electronic resistance system, Double safety protection functions with both emergency stop and stop, High-power Hi-Fi system; MP3 audio input, Smart fan.

4. **Six multi-station Modular Fitness Equipment: Quantity= 1 No.**
   It shall be used for twist, low lat pull, leg press, chest press, butterfly, high lat pull, leg extension. Exercise position: muscle of whole body.

5. **Multi-Station Push Pull Up Chin Dip Bar: Quantity= 1 No.**
   Multi-station workout power tower exercise station for working upper and lower body, exercise your abdominal muscles, biceps, triceps, chest, arms, back, etc. It shall have Pull-up bar, Push-up bar, Dip station for triceps; knee raise station for legs, thick cushioned arm rests and back rest for added comfort. In addition to these it shall have been constructed with heavy duty steel with D-frame base for enhanced stability and durability.

6. **Dumbbells (Chrome Plates) and Dumbbell rods: Quantity= 400 kg**
   Contractor shall provide dumbbells and dumbbell rods as per requirements.
   Dumbbells plates
<table>
<thead>
<tr>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 kg</td>
</tr>
<tr>
<td>1 kg</td>
</tr>
<tr>
<td>2.5 kg</td>
</tr>
<tr>
<td>3 kg</td>
</tr>
<tr>
<td>5 kg</td>
</tr>
<tr>
<td>10 kg</td>
</tr>
</tbody>
</table>
   Dumbbell rods
   | 30 pcs |
   Contractor shall provide chrome surface cast iron weight plate/ dumbbell sheet of higher standard.

7. **Gym ball: Quantity =4 Nos. (65 cm and 75 cm size ball, 2 Nos. each)**
   Gym ball shall be ultra-tough, burnt resistant rubber, perfect for tough or weighted exercises, deflates slowly when punctures, with a non-slip surface for safe, everyday use.

8. **Curve Sit Up Bench: Quantity = 3 Nos.**
   It shall be multi-functional sit up bench, built from heavy duty 4-way steel frame with 2 extra supporting tubes. The thickness of steel frame shall be 12
gauges for the frame and 14 gauges for standing feet. It shall have wider back pad, leather wrapped padded rollers. This equipment shall accommodate sit-up, push up, bend and straighten of back and lying leg raise.

9. **Multi Proposed Bench (Bench Press, Straight, Inclined, Decline, ABS) with weight lifting Bar holding stand: Quantity =3 Nos.**
The bench shall be heavy duty, compact frame retained shape for quality and durability, high density upholstery resists rips and supports body movement, include gym-rack style bar catches to ensure safety and foam roller pads for stability and comfort for legs. It shall be used for users of all experience levels, works well with exercises that use dumbbells or barbells, and also can be adjusted to incline, flat, decline position to engage different muscle groups and leg extension with a weight plate holder let to perform leg-based exercises.

10. **Adjustable and Folding Weight Benches: Quantity= 5 Nos.**
The bench shall be heavy duty, compact frame retained shape for quality and durability. It can be adjusted to six different positions, 17-degree decline to 90-degree incline. It shall have correct posture and stabilize positioning for a safe, muscle-building free-weight workout.

11. **Rubber GYM Mat: Quantity= 5 Nos.**
Contractor shall provide Gym mat made from high quality rubber. It shall be of size at least 5’ by 7’ and 1 inch thickness. It shall have listed features as anti-slip; even on a wet surface, noise and vibration damping, suitable for indoor and outdoor, thermal conductivity of about 0.14 W.m²K and 100% recyclable.

12. **Weight Lifting Bars (straight): Quantity= Each 3 Nos.**
Contractor shall provide 3 ft. 4 ft. 5ft. and 6ft. weight lifting bars each 3 Nos. Bars shall be made of steel and feature a chrome finish with diamond knurled hand-grips for comfort and security while lifting. Bars shall also equipped with smooth ends and include two safety spin locks for extra security.

13. **Weight Lifting Curling Bars: Quantity= 2 Nos. each**
Contractor shall provide 3 ft. and 4 ft. weight lifting bars each 2 Nos. Bars shall be made of steel and feature a chrome finish with diamond knurled hand-grips for comfort and security while lifting. Bars shall also equipped with smooth ends and include two safety spin locks for extra security.

**Note:** Sample of all above shall be submitted to the employer for approval.

23.2 **TABLE TENNIS BOARD: Quantity= 1**
Contractor shall provide Table Tennis board of standard size (Length= 273cm, width=152.5 cm and height= 76 cm) in Udipur. The table must be made of Masonite, layered with a smooth and low friction coating; table surface must be in green or blue color with a white side line which is 2 cm along its width and length. The table tennis board shall be made as per international standard specified by International Table Tennis Federation (ITTF).

23.3 **POOL BOARD WITH ITS ACCESSORIES: Quantity= 1 set**
Contractor shall provide a pool board with complete set of its accessories in Udipur. It shall have traditional claw leg billiard table featuring scratch resistant luster long finish to resist wear and tear, K66 rubber bumpers for consistent bounce, traditional
parlor style drop pocket design, leg levelers for precision play and complete accessories i.e. four wooden billiard cues and sticks, 1 set of billiard balls, 2 pieces of billiard chalk, 1 billiard triangle and 1 table brush. Dimension of this table shall be 87” x 50” x 31”.

Note: Sample of all above shall be submitted to the employer for approval.

24. STORE BUILDING

GENERAL

The scope includes design, engineering and construction, including anti-termite treatment, plinth protection, DPC, peripheral drains, electrification etc. of store building.

The store building shall be essentially single storied reinforced cement concrete (RCC) framed Building with sloping roof of steel tubular truss and 0.63 mm thick CGI roof sheet. The internal electrification shall be designed in accordance with the requirements as specified in relevant section of technical Specification. The half portion of building shall be semi closed with brick wall of 0.9 m high above floor level and second half as closed type with brick wall up to full height above floor level. Semi closed store building shall be provided with MS grill (made of 6 mm thick and 16 mm wide MS flat with suitable steel frame) of suitable pattern above brick wall of 0.9 m high and this grill will extend up to bottom of tie beam of roof. Suitable toe wall of brick masonry in cement sand mortar (1:6) shall be provided below plinth beam to retain plinth filling.

AREA REQUIREMENTS

The approximate size of building is 30 m X 10 m X 4 m high which may vary during detailed engineering stage. The height of building shall be measured from finished floor level to top of roof slab/tie beam.

DESIGN CRITERIA

The Building shall be designed:

1. To the requirements of the relevant /British standards/ equivalent International standards quoted therein, and as specified in this specification.

2. for the specified climatic and loading conditions.

3. with a functional and economical space arrangement.

4. To be aesthetically pleasing.

5. With, wherever required, fire retarding materials for walls, doors etc., which would prevent supporting or spreading of fire and shall be decided by the bidder.

6. Suitable Expansion joints, wherever required, shall be provided as per Codal Provisions.

7. All the members of the buildings frame shall be designed for the worst combination of Loads as per relevant International standards/British Standards.

8. Permissible stresses for different load combinations shall be taken as per relevant International standards/British Standards.

9. Seismic analysis of the building for Earthquake forces shall be carried out as per relevant International standards/British Standards.
DESIGN LOADS

1. Building structure shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, wind loads, seismic loads etc. Any other incidental load, if anticipated, shall be duly accounted for in the design, and shall be clearly mentioned by the bidder.

2. Dead loads shall include the weight of structures complete with finishes, fixtures and partitions, and shall be taken as per relevant International standards/British Standards.

3. Super-imposed loads in different areas shall include live loads, loads from stored material etc.
   a) Non-accessible Roof – 0.75 kN/m².
   b) Accessible Roof – 150 kN/m²

4. Wind loads shall be calculated as per relevant International standards/British Standards. The Factors affecting the wind speed shall be taken based on the site conditions.

5. Earthquake loads shall be calculated as per relevant International standards/British Standards.

6. Wind forces and Seismic forces shall not be considered to act simultaneously.

7. All the load combinations to create worst combinations of loads shall be as per relevant International standards/British Standards.

8. Floors shall be designed to carry loads imposed by stored material (1000 kG /Sq. M), movement of maintenance trucks (if required) and any other load associated with the building. In general, floors shall be designed for live loads as per relevant International standards/British Standards.

FLOORS, WALLS & ROOFS

The floor shall be constructed with 52 mm thick cement concrete finished with metallic hardener topping. 150 mm thick base plain cement concrete layer, 100 mm thick compacted local sand filling and 200 mm thick hard core of stone ballast with interstices filled with local sand shall be laid below cement concrete flooring top. The earth filling below floor shall be well rammed.

PLASTERING

External surfaces of building shall have 18 mm thick plaster in two layers, with the under layer 12mm thick 1:5 cement sand (coarse) plaster and the top layer 6 mm thick 1:6 cement sand (coarse) plaster. Inside wall surfaces shall have 12/15 mm thick 1:6 cement sand (coarse) plaster. Rough surfaces shall have 15mm and smooth surface shall have 12 mm thick cement sand plaster.

EXTERNAL PAINTING

External surfaces of the Building shall be painted with acrylic exterior flat paint as per manufacturer's specification and approval of NEA/Consultant.

DOORS, WINDOWS AND VENTILATORS

The schedule of doors, roller shutter, windows and ventilators of the Building shall be of steel as per relevant International standards/British Standards. Rolling Steel shutters shall be provided as per the layout and requirements of the building. Main entrance door to the store Building shall be MS door frame with M.S. sheet double shutter. Windows and ventilators shall be of steel made of hot rolled sections
windows and ventilators shall be provided with 5.5 mm thick glazing.

PLINTH PROTECTION

750 mm wide plinth protection all-around the building shall be provided. Plinth protection shall comprise of 50 mm thick PCC (1:2:4) laid over 75 mm thick well compacted stone aggregates with interstices filled with local sand including smooth finishing top.

BUILDING STORM WATER DRAINAGE

1. The building design shall provide for the collection of storm water from the roof. This water shall be drained to the main drainage system of the Sub-station.
2. Cast Iron Rainwater down comer pipes conforming to relevant International standards/British Standards with water tight lead joints or medium class galvanized mild steel pipes conforms to relevant International standards/British Standards shall be provided to drain off the rain water from the roofs. These pipes shall be suitably concealed with masonry work or cement concrete or cladding material.
3. Suitable arrangements for draining out water collected from equipment blow downs, leakages, floor washings, firefighting etc. shall be provided, if found necessary.

DETAILS OF ROOF

Roof of the Building shall be sloping type made of steel tubular truss and 0.63 mm thick CGI sheet. All necessary hooks, J bolts, washers and nuts etc required to fix CGI sheet with truss shall be provided. The roof shall be leak proof and holes shall be properly sealed. The truss may be fixed with RCC tie beam and column with MS plate and bolts properly grouted. Suitable MS gutter/truff al along the face of roof sheet shall be provided to collect rain water from roof to finally discharge into rain water pipes. All steel work shall be provided with a priming coat of standard steel primer followed by one coat of epoxy paint and final coating of PU (Minimum 100 micron). The steel work for aforesaid members shall be provided with suitable treatment of shot blasting before application of steel primer.

DETAILED FINISH SCHEDULE

The detailed finish schedule for store building is given below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>LOCATION</th>
<th>FLOORING &amp; SKIRTING 150 MM HIGH</th>
<th>WALL (INTERNAL)</th>
<th>CEILING</th>
<th>ROLLER SHUTTER, DOOR, WINDOWS &amp; VENTILATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Store Building</td>
<td>62mm thick cement concrete flooring with metallic hardener topping. skirting shall be of cement</td>
<td>Oil bound washable distemper on masonry portion.</td>
<td>Sloping roof of CGI sheet.</td>
<td>Windows/ ventilator shall be hot rolled steel section with 5.5mm thick glazing. Entry door shall be of M.S. Sheet double shutter and rolling shutter shall be of steel. MS steel grill shall be provided</td>
</tr>
</tbody>
</table>
sand plaster. for semi closed type store. Steel work shall be provided with one coat of steel primer and two coats of synthetic enamel paint of standard make.

**ELECTRIFICATION**

All electrification shall be executed as per details specified elsewhere in the technical specification. All details shall be as per relevant British standard codes (B S Codes)/ equivalent International Standards.

**MEASUREMENT**

The building shall be measured and paid on Square meter area basis. Items like excavation, plain Concrete, reinforced cement concrete and reinforcement steel shall be measured and paid separately under respective items of BPS and all other items including electrification, finishing, steel grills, windows, shutter etc to complete the building shall be deemed to be included in unit rate of building.

### 25. BOUNDARY WALL, MAIN GATE, SECURITY ROOM AND SEPTIC TANK AND SOAK PIT

#### 25.1 Boundary Wall:

RCC framed with brick masonry/concrete block/stone masonry in fill between columns shall be provided along periphery of substation. The brief description of boundary wall is given below:

(a) Height of boundary wall (Masonry portion) above ground = 2.5 m  
(b) 0.5 m Height of Y shaped angle supports (50x50x6 mm) above each column with about 0.5 m deep grouted in column shall be provided as grill on the boundary wall  
(c) C/c distance of RCC Column (230 X 230 mm size) = 2.5 m  
(d) 8 rows of galvanised barbed wire with concertina coil a top of boundary wall shall be provided. 4 rows of barbed wire on each arm of Y-shaped angle is to be provided.  
(e) Grade of Concrete for RCC works = M25  
(f) Mix of masonry works = 1 Cement: 6 Sand  
(g) 12 mm thick Cement sand plaster (1 cement: 6 Sand) over exposed portion of boundary wall along with 50mm thick CC (1:2:4) coping on the top of wall.  
(h) Two coats of oil bound distemper with one coat of cement primer of approved make shall be applied over exposed portion of boundary wall.  
(i) A RCC plinth beam (230 X 300 mm deep) shall be provided at ground level. A lintel beam of 230 X 230 mm shall be provided over gratings.  
(j) Suitable steel grating made of 20 mm square bars shall be provided at suitable locations preferably @ 100 m to allow the flow of surface water.  
(k) Suitable foundation of about 1.5 depth shall be provided for each RCC column. 75 mm thick PCC (1:4:8) layer shall be provided below all RCC works.  
(l) All steel works shall be provided with two coats of synthetic enamel paint over a coat of steel primer of approved make.
(m) Twin columns with 25 mm expansion gap at every 45 meter length shall be provided.

(n) Suitable design of boundary wall shall be developed by the contractor.

The boundary wall shall be measured and paid on running meter length basis.

25.2 **MAIN GATE**

A steel gate of 2.1 m high and 6 m wide along with 1.5 m wide man gate shall be provided at entry location of substation. The gate shall be supported on steel columns. The steel support columns shall be encased with suitable RCC foundations. Suitable wheel mounting arrangement shall be provided at the bottom of gate for smooth opening of gate. All steel works shall be provided with two coats of synthetic enamel paint over a coat of steel primer of approved make.

The item shall be measured and paid on Lump sum basis.

25.3 **SECURITY ROOM**: A RCC framed room of size 3 m X 3m and 3 m high with 1.5 m wide veranda shall be provided near gate. An attached toilet of 1.5 m x 1.5 m size shall be provided. Suitable septic tank and soak pit for 10 users with cleaning interval of 3 years shall also be provided. A RCC platform (600 mm wide) at window sill level along with wardrobe shall be provided. All sanitary works and a PVC water tank of 1000 litre capacity shall also be provided. All finish details shall match with other buildings mentioned elsewhere in the technical specification.

The item shall be measured and paid on square meter area basis.

26. **MODE OF MEASUREMENT**

26.1 **GEOTECHNICAL INVESTIGATION**

This shall include carrying out field tests, laboratory tests, compilation of results and preparation of soil report with recommendations for type of foundations shallow or pile type, suitability of soil for construction of substation etc. The geotechnical investigation work shall be measured on lump sum basis.

26.2 **CONTOUR SURVEY, SITE LEVELING AND RETAINING WALLS.**

The Contour survey work shall not be measured and paid separately and shall be deemed to be included in the item of site leveling work. Measurement of Earth work in all kind of soil including soft/disintegrated rock in the item of cutting and filling and item of earth work in the filling with borrowed earth shall be made in Cubic meters. No void deduction for 95% compaction.

26.3 **EARTHWORK**

This shall include excavation in all kinds of soil including rock, all leads and lifts including back filling with suitable earth, compacting, dewatering (if required) and disposal of surplus earth or rock to a suitable location within a lead up to 2 km. The surplus earth if disposed within substation boundary shall be spread in uniform layers each compacted with two passes of suitable compacting equipment. The quantity of excavation for foundations of towers, equipment support structures, all
transformers/Reactors, DG Set, firewall, cable trenches, fire fighting water tank, buildings and underground water tanks, covered car parking, External lighting poles, control cubicles, marshalling box, retaining walls shall only be measured. The quantity of excavation for roads, rail cum road, drains, culverts, rainwater harvesting, septic tank, soak pit, external water supply system, site surfacing, chain link fencing (including gate) shall not be measured separately and shall be deemed to be included in the composite rates quoted by the bidder for the respective works. All other excavation required for the completion of the work including plinth protection, flooring, sewerage system, manholes, pipes, earth mat etc. shall also not be paid for. The measurement of excavation of all concrete works shall be made considering dimension of the pit leaving 150mm gap around the base pad (lean concrete) or actually excavated pit, whichever is less. The quantity shall be measured in cubic metres.

26.4 PCC

Providing and laying Plain Cement Concrete of all types and at all locations including all leads and lifts. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings.

26.4.1. PCC 1:2:4 (1 cement : 2 sand : 4 coarse aggregate 20 mm nominal size) shall be measured in flooring of buildings, plinth protection, fencing, transformer/reactor foundation, rail track, drain, culverts, septic tank, chain link fencing, fencing gate, external lighting poles etc. as indicated in the approved drawings.

26.4.2. PCC 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate, 40mm nominal size) shall be measured below all foundations of towers, equipment support structures, buildings, firefighting water tanks, covered car parking, cable trench, roads, under flooring, rail-cum-road, transformer foundation, reactor foundation, drain, cable trench crossings, culverts, fence, gate etc. as indicated in the approved drawings.

26.4.3. PCC 1:5:10 (1 Cement: 5 sand: 10 Stone aggregate, 40mm nominal size) shall be provided for site surfacing in switchyard, roof water proofing etc.

All other PCC required for the completion of the work including hold fasts of doors/windows/rolling shutters, fixing of plumbing pipes, bedding concrete for sewer lines, embedment of electrical conduits etc. shall not be measured and deemed included in the composite rates quoted by the bidder for respective works. Water proofing compound wherever specified shall be added without any extra cost.

26.5 RCC

Measurement of reinforced cement concrete at all locations shall be made and shall include all leads, lifts, formwork, grouting of pockets and underpinning, (but shall exclude reinforcement & miscellaneous structural steel like inserts etc.), of M25 design mix (Minimum). This shall also include pre-cast RCC work and addition of water proofing compound wherever required for which no additional payment shall be made. The quantity shall be measured in cubic meters as per lines and levels indicated in the drawings. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings having cross-sectional area up to 0.1 Sq. M

26.6 STEEL REINFORCEMENT
Reinforcement steel shall be measured in length (actual or theoretical as per drawing whichever is less) including hooks, if any, separately for different diameters as actually used in RCC work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in metric tonnes on the basis of sectional weights as adopted by British Standards/equivalent International standards. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

26.7 **STONE FILLING OVER GRATING IN TRANSFORMER/REACTOR FOUNDATION**

Measurement of stone (40mm nominal size) filling over gratings of transformer/reactor foundations shall be made as per theoretical volume of the space to be filled in the transformer foundation as per approved drawings. This shall be measured in Cu. M.

26.8 **MISCELLANEOUS STRUCTURAL STEEL**

Measurement for Supply, fabrication, transportation and erection of all miscellaneous structural steel work for rails along with rail fixing details and gratings with supports for transformers/reactors, Cable trenches with covers (Chequered plate covers, cable supports, earthing cleats and edge protection angles etc.), all other steel fittings and fixtures, inserts and embedment in concrete of transformer/reactor foundation and cable trenches shall be made as per approved drawings. The unit rate for this item shall be inclusive of cutting, grinding, drilling, bolting, welding, pre- heating of the welded joints, applying a priming coat of steel primer and anti-corrosive bitumastic paint/ synthetic enamel paint in general but with Zinc Phosphate Primer (Two packs) for grating and support for grating in Transformer foundation. (Wherever specified), setting of all types of embedment in concrete, etc. Steel required for foundation bolts, nuts and bolt, doors, windows, ventilators, louvers, rolling shutters, chain link fencing, gratings in drains, soil pipes, plumbing pipes, floor traps, embedment’s required for rainwater harvesting, septic tank, soak pit, roof truss and purlins required for fire water tank, etc. shall not be considered for payment and measurements. Quantity shall be measured in metric tonnes.

26.9 **ROADS**

A) The measurement for the concrete road shall be made on the basis of area in square meter (M2) of top concrete completed surface of the road and shall be deemed to include all items such as excavation, compaction, rolling, watering, WBM, shoulder, etc. complete as per approved drawing but excluding concreting and reinforcement which shall be paid separately under respective items of BPS.

B) The measurement of bituminous road shall be made on the basis of area in square meter (M2), of the top bituminous completed surface of the road and shall include all items such as excavation, compaction, rolling, watering, sub base course, WBM, shoulder, premix carpet etc. complete as per approved drawing.

C) The measurement of strengthening of existing road (bituminous road) shall be made on the basis of area in square meter (M2), of the top bituminous completed surface of the road including premix carpet etc. but excluding item of granular sub base course which shall be paid separately under respective item of BPS.
26.10 **ANTI-WEED TREATMENT AND STONE SPREADING**

The measurement shall be done for the actual area in square metres of stone spreading provided in the switchyard. It includes providing and spreading of 100mm thickness of uncrushed/crushed/broken stone of 40mm nominal size as per relevant BS codes/equivalent International standards for the specified area. Application of anti-weed treatment including material shall not be measured separately and item would be deemed to be included in the quoted rate of stone spreading in switchyard.

26.11 **CHAIN LINK FENCING AND GATE**

The measurement shall be made in running metres of the fence provided as per approved drawing. The rate shall be including the post, fencing, MS Flat, painting, brick work and plaster of toe wall etc. complete but excluding the concrete. The switch yard gate shall be measured in numbers.

26.12 **CABLE TRENCHES AND CABLE TRENCH CROSSINGS**

Earthwork, PCC, RCC, reinforcement steel, RCC Hume pipes and miscellaneous steel required for construction of Cable Trenches and cable trench crossings shall be measured under respective items of Bid price schedule (BPS) as described in clauses of aforesaid paras. No additional payment for brick work, plaster and PVC pipes used for cable trench crossings and sealing of trench mouth shall be admissible.

26.13 **DRAINS & CULVERTS**

PCC (1:2:4 and 1:4:8) for drains and culverts shall be measured under respective items of Bid price schedule (BPS) as described in clauses of aforesaid paras. All other items like excavation, brick work, plaster and stone pitching except RCC Hume pipes required for completion of drains and culverts shall be deemed to be included in the quoted rate of drain. The quantity for each type of drain section shall be measured in running meters. However, RCC Hume pipes used in culverts shall be measured under respective item of Bid price schedule (BPS) as described in clause of Hume pipes.

26.14 **EXTERNAL FINISHING OF RCC FRAMED BUILDINGS/STRUCTURES:**

The item shall be measured per square meter area basis. Contractor has to assess the quantity as per requirement of Control room cum administrative building, Fire Fighting Pump House, firefighting water tank, switchyard panel room, residential and non-residential buildings, covered car parking and quote for the same separately. This shall include following items.

1) External plastering/cement wash : 18mm Cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement: 5 coarse Sand) finished with a top layer of 6 mm thick cement plaster 1:6 (1 cement: 6 fine Sand) for all buildings and firefighting water tank.

2) Providing and applying two or more coats of Acrylic smooth exterior paint over an under coat of suitable primer on new cement plaster surfaces of the control room building, auxiliary building, firefighting pump house building, firefighting water tank, panel room, residential and non-residential buildings and covered car parking. It shall be inclusive of required tools, scaffolding,
materials and other painting accessories etc. as per recommendations of manufacturer.

26.15 **HUME PIPE**

Hume pipe shall be measured diameter-wise and laid as per approved drawings and shall be measured in running meters. The item shall be inclusive of excavation, laying, back filling, jointing etc. but excluding concrete and reinforcement (if any).

26.16 **BUILDING**

The measurement of all items except excavation, concrete, reinforcement steel of each type of buildings shall be made on area in Square Meter basis. However, the quantity of excavation, concrete, reinforcement steel shall be measured separately under respective items of BPS and described in above paras. The structural steel used for cable tray support, earthing cleat, chequered plates for internal cable trenches of building and panel room wherever applicable shall be measured and paid under miscellaneous steel item of BPS and described above paras. The structural steel and foundation bolts for fixing equipments with foundations/raft within buildings shall not be measured separately which shall be deemed to be included in the quoted rates per square meter of buildings. External Finishing shall be measured and paid in respective items of BPS and described in above paras. The rest of the entire work required to complete the building in all respect as per drawings prepared by contractor and approved by NEA/Consultant shall be deemed to be included in this item rate per square meter area basis.

26.17 **RAIN WATER HARVESTING**

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings prepared by contractor and approved by NEA/Consultant. All the items including excavation, miscellaneous steel, brick work, fillings of boulders, gravel, sand, pipes etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under respective item of BPS and described in above paras.

26.18 **RAIL CUM ROAD**

The measurement for the rail cum road shall be made in square metres of top concrete completed surface of the rail cum road and shall include all items such as excavation, compaction, rolling, watering, WBM etc. complete as per approved drawing but excluding concrete, reinforcement, structural steel and rails with rail fixing details which shall be measured separately under respective item of BPS and described in above paras.

26.19 **SEPTIC TANK AND SOAK PIT**

This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings furnished by the contractor and approved by NEA/Consultant. All the items including excavation, masonry work, all types of fillings, all types of pipes including plumbing and vent pipes, all type of fittings etc. shall be deemed to be included in this lump sum rate. However, the concrete (all types) and the reinforcement shall be measured and paid under the respective item mentioned above.
26.20 **FIRE WATER TANK**

This is a lump sum item. The contractor shall be required to complete the work in all respect as per approved drawings. The items including brick work if any, and miscellaneous steel including steel embedment Rungs, roof truss, corrugated AC Sheet roofing, door, pipe sleeves, internal finish, etc. shall be deemed to be included in this lump sum cost. However, the items like excavation, concrete (all types), reinforcement steel, external finish shall be measured and paid under the respective item of BPS and described in above paras.

26.21 External water supply from Bore-well/ other source of water supply arrangement to Fire water tank, Control Room building, Residential and nonresidential buildings

The external water supply from Bore-well shall be measured diameter-wise in running meters. It shall include all the items such as excavation, piping, pipe fittings, painting, brickwork, sand filling, concrete, valves, chambers cutting chases in walls, openings in RCC and repairs, etc. required to complete the job.

26.22 External Sewage System of Control Room Building and other Buildings of Township.

It shall be measured diameter wise in running meters. It shall include all the items such as excavation, piping, pipe fittings, manholes, gali trap, gali chamber casing in concrete and repairs etc required to complete the job. Any modification in the existing sewage system, if required, shall be done by the Contractor without any extra cost implicated to NEA/Consultant.

### 27. MISCELLANEOUS GENERAL REQUIREMENTS

27.1 Dense concrete with controlled water cement ratio as per BS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

27.2 All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

27.3 All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.

27.4 All mild steel parts used in the water retaining structures shall be hot-double dip galvanised. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanised structures and shall comply with relevant BS. Galvanizing shall be checked and tested in accordance with relevant BS. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416.

27.5 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to relevant BS shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water
retaining structures.

27.6 Bricks having minimum 75 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm² compressive strength before submitting his offer. The contractor may use concrete blocks of equivalent compressive strength in place of brick work.

27.7 Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sun-shade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

27.8 All stairs shall have maximum riser height of 150 mm and a minimum tread width of 300 mm. Minimum width of stairs shall be 1500 mm. Service ladder shall be provided for access to all roofs. RCC fire escape staircase if required as per local bye laws, shall be provided in control buildings.

27.9 Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.

27.10 Anti termite chemical treatment for buildings shall be given to all column pits, wall trenches, foundations, filling below the floors etc. as per relevant International/BS.

27.11 Hand-railing minimum 900mm high shall be provided around all floor/roof openings, projections/balconies, walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanised (medium-class as per relevant BS). All rungs for ladder shall also be galvanised as per relevant BS.

For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats & aluminium handrails shall be provided.

27.12 For all civil works covered under this specification, design Mix of Minimum M25 grade as per relevant International /BS shall be used. Reinforcement steel shall be of minimum Fe 500 grade.

The material specification, workmanship and acceptance criteria shall be as per relevant clauses of applicable International/BS standard.

27.13 Items/components of buildings not explicitly covered in the specification and BPS but required for completion of the project shall be deemed to be included in the scope.

27.14 Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the International/BS Standards based on the findings of the detailed soil investigation to be carried out by the Bidder.

27.15 Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in relevant BS and other International Standards.
27.16 All water retaining structures designed as uncracked section shall also be tested for water tightness at full water level in accordance with relevant international/BS standards.

27.17 Construction joints shall be as per International/BS standard.

27.18 All underground concrete structures like basements, pumps houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to relevant BS. The concrete surface of these structures in contact with earth shall also be provided with two coat of bituminous painting for water/damp proofing.

In case of water leakage in the above structures, The Method shall be applied as per relevant international standard/BS standard for repairing the leakage.

27.19 All building/construction materials shall conform to the best quality specified in relevant International/BS standard.

28. INTERFACING

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment’s, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

29. STATUTORY RULES

29.1 Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules of Tariff Advisory Committee and Water and sewerage Act for pollution control etc.

29.2 Provisions for fire proof doors, no. of staircases, fire escape stairs, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Local Advisory Committee.

29.3 Statutory clearance and norms of Local Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

30. FIELD QUALITY PLAN

All tests as required in accordance to BS codes or equivalent International standards have to be carried out. The contractor shall prepare field quality plan for civil works as per relevant /BS codes/equivalent International Standards during detailed engineering stage and submit to NEA/Consultant for approval within ONE month after award of work.

31. BRITISH STANDARD CODES
Major British standard Codes for civil work have been given in the following list. This list is illustrative but not exhaustive. However, for design and engineering relevant BS codes or equivalent International standards shall be referred by the contractor. Relevant portion of BS codes or equivalent international standards referred by the contractor for the design shall be made available to NEA/Consultant if necessary during detailed engineering stage.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Standard No</th>
<th>Title</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BS 41</td>
<td>Structural steel sections. Specification for hot-rolled sections</td>
<td>2005</td>
</tr>
<tr>
<td>2</td>
<td>BS 13771</td>
<td>Methods of test for soils for civil engineering purposes. General requirements and sample preparation</td>
<td>1990</td>
</tr>
<tr>
<td>4</td>
<td>BS 4482</td>
<td>Steel fabric for the reinforcement of concrete. Specification</td>
<td>2005</td>
</tr>
<tr>
<td>5</td>
<td>BS 4483</td>
<td>Steel fabric for the reinforcement of concrete. Specification</td>
<td>2005</td>
</tr>
<tr>
<td>6</td>
<td>BS EN 102102</td>
<td>Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties</td>
<td>2006</td>
</tr>
<tr>
<td>7</td>
<td>BS EN 100561</td>
<td>Specification for structural steel equal and unequal sections. Dimensions</td>
<td>1999</td>
</tr>
<tr>
<td>8</td>
<td>BS EN ISO 8000-01</td>
<td>Quantities and units. General</td>
<td>2013</td>
</tr>
<tr>
<td>9</td>
<td>BS 5930</td>
<td>Code of practice for site investigations (with A2:2010)</td>
<td>1999</td>
</tr>
<tr>
<td>16</td>
<td>BS 60732</td>
<td>Precast concrete masonry units. Guide for specifying precast concrete masonry units</td>
<td>2008</td>
</tr>
<tr>
<td>17</td>
<td>BS 7668</td>
<td>Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification</td>
<td>2004</td>
</tr>
<tr>
<td>18</td>
<td>BS EN 19971</td>
<td>Eurocode 7. Geotechnical design. General rules</td>
<td>2004</td>
</tr>
<tr>
<td>20</td>
<td>BS EN 19923</td>
<td>Eurocode 2. Design of concrete structures. Liquid retaining and containing structures</td>
<td>2006</td>
</tr>
<tr>
<td>No</td>
<td>Document Code</td>
<td>Description</td>
<td>Year</td>
</tr>
<tr>
<td>----</td>
<td>--------------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>23</td>
<td>BS 75334</td>
<td>Pavements constructed with clay, natural stone or concrete pavers. Code of practice for the construction of pavements of precast concrete flags or natural stone slabs</td>
<td>2006</td>
</tr>
<tr>
<td>24</td>
<td>BS EN 1971</td>
<td>Cement. Composition, specifications and conformity criteria for common cements</td>
<td>2011</td>
</tr>
<tr>
<td>25</td>
<td>BS 743</td>
<td>Specification for materials for damp-proof courses</td>
<td>1970</td>
</tr>
<tr>
<td>26</td>
<td>BS 8122</td>
<td>Testing aggregates. Methods for determination of density</td>
<td>1995</td>
</tr>
<tr>
<td>27</td>
<td>BS 952-1</td>
<td>Glass for glazing. Classification</td>
<td>1995</td>
</tr>
<tr>
<td>28</td>
<td>BS 952-2</td>
<td>Glass for glazing. Terminology for work on glass</td>
<td>1980</td>
</tr>
<tr>
<td>29</td>
<td>BS EN 12620</td>
<td>Aggregates for concrete</td>
<td>2013</td>
</tr>
<tr>
<td>30</td>
<td>BS 1125</td>
<td>Specification for WC flushing cisterns (including dual flush cisterns and flush pipes)</td>
<td>1987</td>
</tr>
<tr>
<td>31</td>
<td>BS 1188</td>
<td>Specification for ceramic wash basins and pedestals</td>
<td>1974</td>
</tr>
<tr>
<td>32</td>
<td>BS 1199 and 120 0</td>
<td>Specifications for building sands from natural sources</td>
<td>1976</td>
</tr>
<tr>
<td>33</td>
<td>BS EN 13310</td>
<td>Kitchen sinks. Functional requirements and test methods</td>
<td>2003</td>
</tr>
<tr>
<td>34</td>
<td>BS 1245</td>
<td>Pedestrian doorsets and door frames made from steel sheet. Specification</td>
<td>2012</td>
</tr>
<tr>
<td>35</td>
<td>BS 1254</td>
<td>Specification for WC seats (plastics)</td>
<td>1981</td>
</tr>
<tr>
<td>36</td>
<td>BS 1370</td>
<td>Specification for low heat Portland cement</td>
<td>1979</td>
</tr>
<tr>
<td>37</td>
<td>BS EN 1008</td>
<td>Mixing water for concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, and mixing water for concrete</td>
<td>2002</td>
</tr>
<tr>
<td>38</td>
<td>BS 3505</td>
<td>Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water</td>
<td>1986</td>
</tr>
<tr>
<td>39</td>
<td>BS EN 15743</td>
<td>Supersulfated cement. Composition, specifications and conformity criteria</td>
<td>2010</td>
</tr>
<tr>
<td>40</td>
<td>BS EN ISO 3766</td>
<td>Construction drawings. Simplified representation of concrete reinforcement</td>
<td>2003</td>
</tr>
<tr>
<td>41</td>
<td>BS 8666</td>
<td>Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. Specification</td>
<td>2005</td>
</tr>
<tr>
<td>42</td>
<td>BS 4514</td>
<td>Unplasticized PVC soil and ventilating pipes of 82.4 mm minimum mean outside diameter, and fittings and accessories of 82.4 mm and of other sizes. Specification</td>
<td>2001</td>
</tr>
<tr>
<td>43</td>
<td>BS 4551</td>
<td>Mortar. Methods of test for mortar and screed. Chemical analysis and physical testing (with A2:2013)</td>
<td>2005</td>
</tr>
<tr>
<td>44</td>
<td>BS EN 122001</td>
<td>Plastics rainwater piping systems for above ground external use. Unplasticized poly (vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system</td>
<td>2000</td>
</tr>
<tr>
<td>45</td>
<td>BS EN 1462</td>
<td>Brackets for eaves gutter. Requirements and testing</td>
<td>2004</td>
</tr>
<tr>
<td>46</td>
<td>BS EN 607</td>
<td>Eaves gutters and fittings made of PVC-U. Definitions, requirements and testing</td>
<td>2004</td>
</tr>
<tr>
<td>47</td>
<td>BS 6262</td>
<td>Code of practice for glazing for buildings</td>
<td>1982</td>
</tr>
<tr>
<td>48</td>
<td>BS EN 14411</td>
<td>Ceramic tiles. Definitions, classification, characteristics, evaluation of conformity and marking</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td>BS 6510</td>
<td>Steel framed windows and glazed doors. Specification</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
<td>-----------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>50</td>
<td>BS EN 636</td>
<td>Plywood. Specifications</td>
<td>2012</td>
</tr>
<tr>
<td>52</td>
<td>BS EN 1339</td>
<td>Concrete paving flags. Requirements and test methods</td>
<td>2003</td>
</tr>
<tr>
<td>53</td>
<td>BS EN 1340</td>
<td>Concrete kerb units. Requirements and test methods</td>
<td>2003</td>
</tr>
</tbody>
</table>